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BRENT WILEY
Editor

JAMES D. KELLY
Advertising Mgr.

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BRENT WILEY
Editor

JAMES D. KELLY
Advertising Mgr.

A new principle—A new result!

Better INGOTS ..BETTER STEEL with the AMCO PIT FURNACE

Above—Ingot being placed in pit.

At Right—Showing condition of Ingot as it leaves AMCO Pit Furnace; free from wash.

IN pit furnaces of any type where the flame impinges against the ingots, it is difficult to prevent washing and maintain the scale envelope on the stock during heating.

In the AMCO Pit, the flame *does not impinge* against the ingot but circulates along the walls, thus producing a uniform scale condition and eliminating washing.

The result is an improved quality of steel and greatly reduced conditioning costs.

The AMSLER-MORTON COMPANY
FULTON BUILDING • PITTSBURGH, PA.

STEEL MAKES STEAM *with*

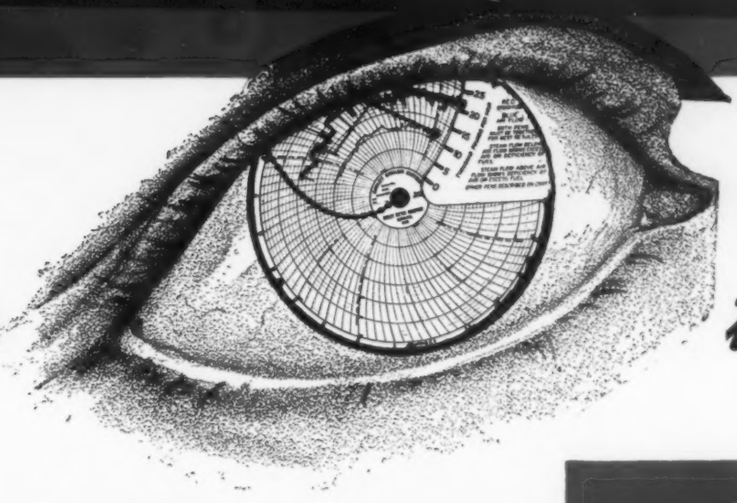
Boiler Control Panels including Bailey Boiler Meters as an integral part of the Bailey Combustion Control System installed on four 500 h. p. stoker-fired boilers in a Steel Mill Power Plant.

OTHER BAILEY PRODUCTS FOR THE STEEL INDUSTRY

- FURNACE DRAFT CONTROL
- FUEL—AIR RATIO CONTROL
- ATMOSPHERE CONTROL
- PRESSURE CONTROL
- GAS MIXING CONTROL
- GAS FLOW METERS
- STEAM FLOW METERS
- AIR FLOW METERS
- WATER FLOW METERS

Bailey Control Drives regulating fuel feed and uptake draft.

BAILEY METER CONTROL



...ith an Eye to Economy

BAILEY METER CONTROL

Continuously Maintains Test Results in Everyday Operation

• To secure day-by-day operating efficiencies equal to those obtained under test conditions is the goal of every power plant engineer. It is by such operation that investments in boiler room modernization are made to pay handsome dividends.

Steam Flow—Air Flow Boiler Meters are an integral part of the Bailey Combustion Control System. These eyes to economy see combustion changes as they occur and automatically operate the control, readjusting fuel feeds as required to obtain optimum combustion conditions in each boiler furnace.

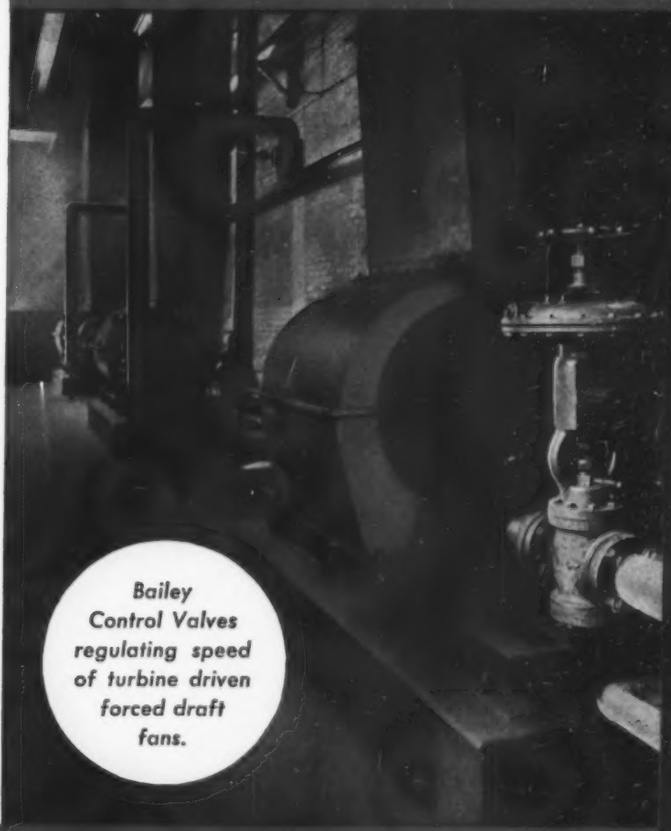
Bailey Meter Control makes possible the maintenance of boiler test standards in everyday operation because it is a complete system which (1) automatically maintains desired steam pressure; (2) automatically maintains most economical fuel—air ratio; (3) automatically maintains desired furnace draft; (4) automatically maintains division of load among boilers.

Detailed information on this sturdy, inexpensive air-operated control system is contained in Bulletin No. 102-A. Your copy will be mailed without obligation upon request.

BAILEY METER COMPANY
1047 IVANHOE ROAD • CLEVELAND, OHIO
Bailey Meter Company Limited, Montreal, Canada 5-6

A FEW OF THE MANY STEEL COMPANIES USING BAILEY METERS

Allegheny Steel Company
American Rolling Mill Company
American Sheet and Tin Plate Co.
American Steel and Wire Co.
The Andrews Steel Company
Bethlehem Steel Company
A. M. Byers Company
Carnegie-Illinois Steel Corp.
The Colorado Fuel & Iron Co.
Empire Sheet & Tin Plate
Great Lakes Steel Corp.
Gulf States Steel Company
Jones and Laughlin Steel Corp.
Lukens Steel Company
The Midvale Company
National Tube Company
Oliver Iron & Steel Corp.
Pittsburgh Steel Company
Reading Iron Company
Republic Steel Corporation
Sharon Steel Hoop Company
Tennessee Coal, Iron & R. R. Co.
Union Drawn Steel Company
Weirton Steel Company
Wheeling Steel Corporation
The Youngstown Sheet & Tube Co.



Bailey Control Valves regulating speed of turbine driven forced draft fans.

The COMPLETE *Combustion Control System*

Use BILLETEERS *and save*

★ MEN
★ MONEY
★ MATERIAL

READ THE REPORT BELOW AND COMPARE WITH YOUR OWN COSTS.

THE BILLETEER SAVES MONEY FOR OTHERS. HAVE YOU INVESTIGATED POSSIBLE SAVINGS IN YOUR PLANT?

REPORT OF BILLETEER OPERATION

(From Customer's Records)

Period of Operation	One Month
Machine Operated	640 Hours
Total Tonnage Chipped	2434 Tons
Average per Hour	3.88 Tons
Class of Steel	Spring Stock Chrome Vanadium Hi Sil Manganese
Sizes Handled	4" x 4" 5" x 5" 6" x 6"
Average Total Cost	88 Cents per Ton

TEST MADE FOR PROSPECTIVE CUSTOMER

Four billets of spring stock 4"x4" were chipped by hand one-half the length all four sides.

The Billeteer was used to chip the remaining half.

Time of hand chipping, 8 hours.

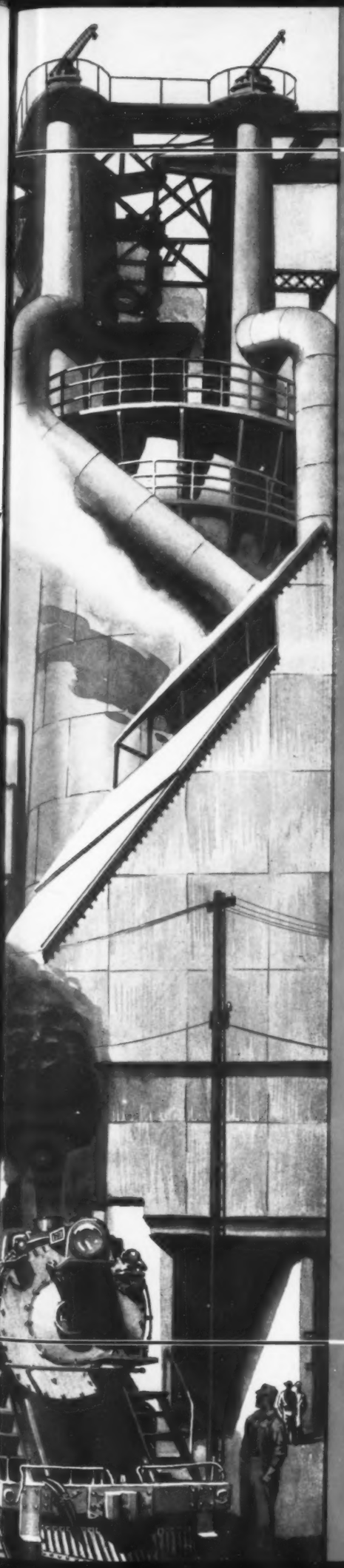
Time of Billeteer, 32 minutes.

Time Ratio, 15:1.

The BONNOT *Co.*

STEEL EQUIPMENT DIVISION

CANTON • OHIO



STEEL'S PARTNER

from ore to market

The name Blaw-Knox has taken on a new meaning. Instead of a single company rendering a certain service to the steel industry, Blaw-Knox now represents the sum total of the facilities, experience, knowledge and man-power of six highly specialized companies, each in itself an important contributor to steel, headed by practical steel men.

To render "Blaw-Knox Service," therefore, means to place at the disposal of a steel plant everything that all the companies composing the Blaw-Knox group can offer. It is a service that starts far in advance of any possible orders for equipment; it originates in the co-operation of Blaw-Knox engineers with plant operating officials; it comprises the ideas and methods of specialists for the advance of production practice and for the development of equipment to meet specified needs.

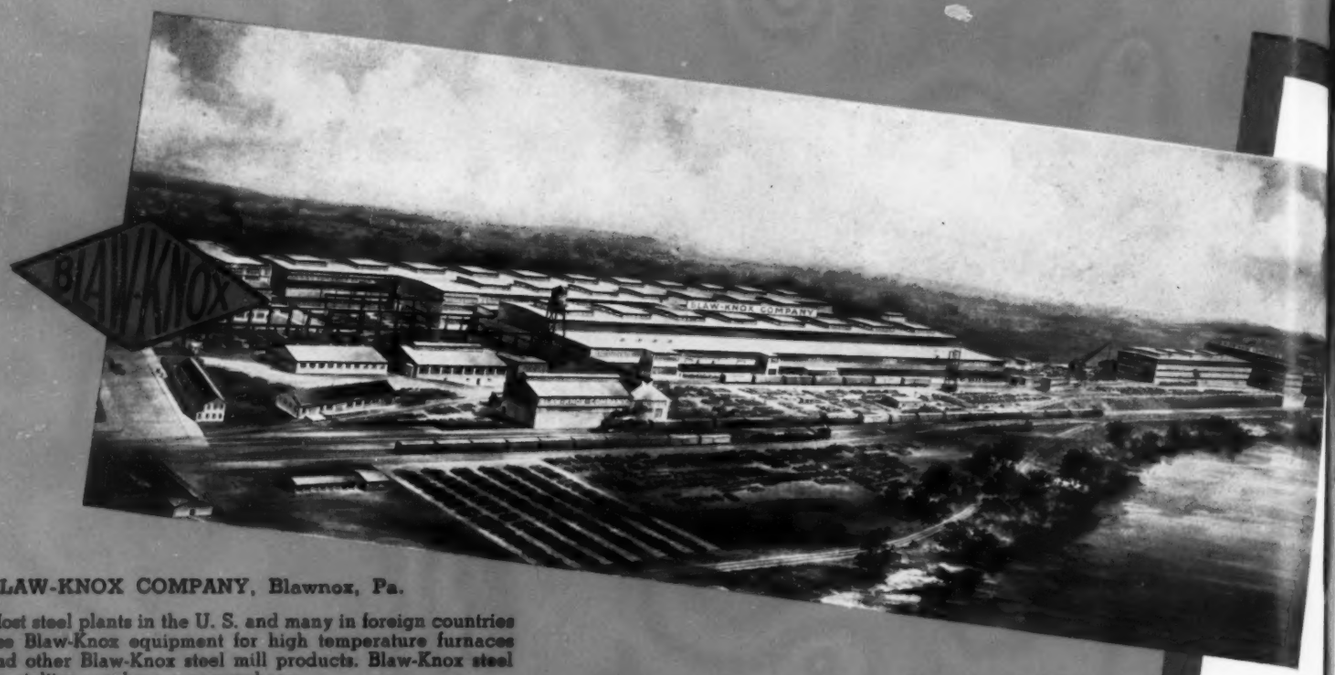
At any time in the history of the steel industry, such a service would have been of great value. It is of incalculable value now. Today the hope for increased profits lies in reducing costs, stepping up production, improving methods.

Blaw-Knox—Steel's Partner—can serve any steel plant, fabricator, or other industrial, large or small, in a way that inevitably will result in greater profits.

BLAW-KNOX
Steel's Partner

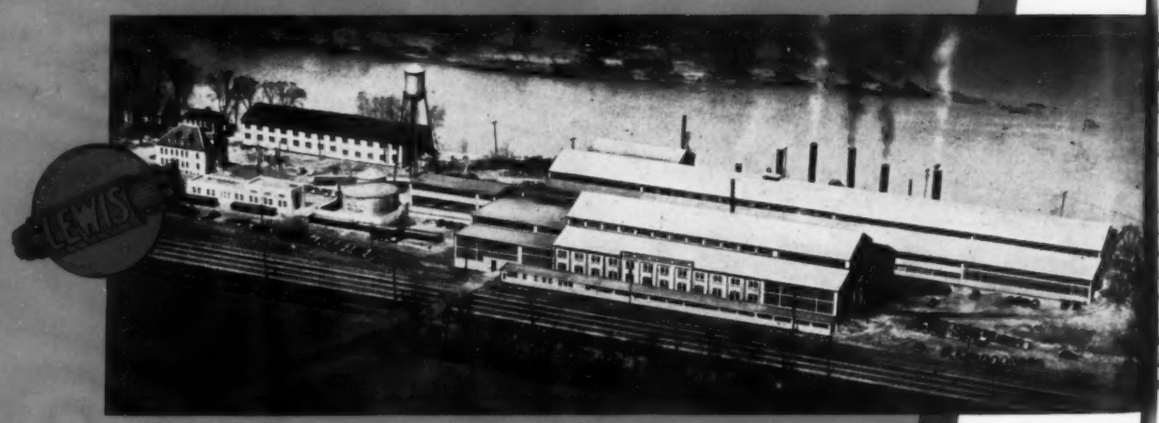
BLAW-KNOX CO., BLAWNOX, PA. · LEWIS FOUNDRY & MACHINE CO., PITTSBURGH, PA. · NATIONAL ALLOY STEEL CO., BLAWNOX, PA.
PITTSBURGH ROLLS CORP., PITTSBURGH, PA. · UNION STEEL CASTING CO., PITTSBURGH, PA. · POWER PIPING CORP., PITTSBURGH, PA.

They have combined
THEIR FACILITIES, EXPERIENCE AND KNOWLEDG TO



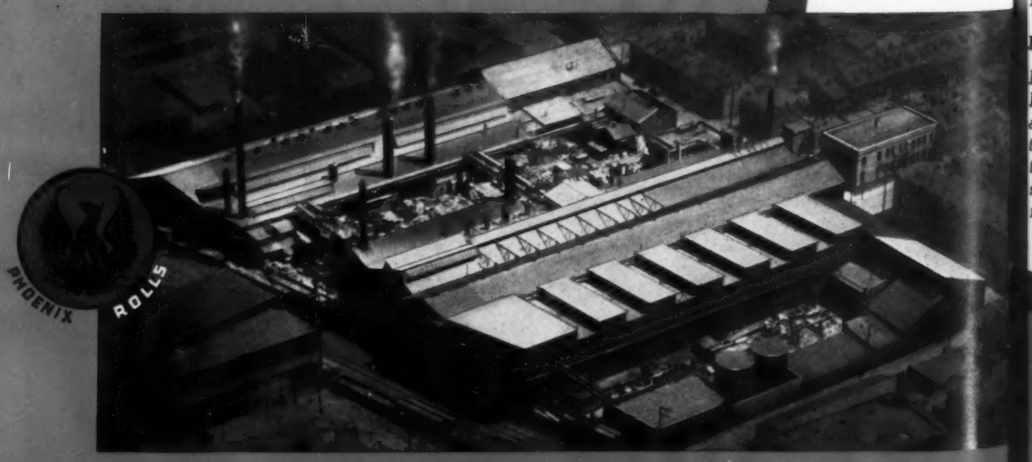
BLAW-KNOX COMPANY, Blawnox, Pa.

Most steel plants in the U. S. and many in foreign countries use Blaw-Knox equipment for high temperature furnaces and other Blaw-Knox steel mill products. Blaw-Knox steel specialties are known everywhere.



LEWIS FOUNDRY & MACHINE COMPANY, Pittsburgh, Pa.

For more than 80 years Lewis Rolls and Rolling Mill equipment has shared the progress of steel. The Lewis list of products covers much of the machinery needed in the modern rolling mill.



PITTSBURGH ROLLS CORPORATION, Pittsburgh, Pa.

Phoenix rolls for rolling mills. This Company makes rolling mill rolls only and the men responsible for this highly specialized product have devoted lifetimes to this work.

DG TO RENDER THIS WIDER SERVICE TO STEEL

PARTIAL LIST OF PRODUCTS

BLAW-KNOX COMPANY

Water cooled doors and frames, valves, ports, slag line coolers, bulkhead coolers, burner coolers, mantel coolers, buck-stays, preheaters, dolomite machines, sloping backwalls, Venturi furnaces, single motor door hoists, annealing boxes, covers and pots, galvanizing kettles, etc., clamshell buckets, steel grating and treads, standard buildings, steam purifiers, gas cleaners, etc.

LEWIS FOUNDRY & MACHINE COMPANY

Chilled iron and iron alloy rolls for iron, steel, brass, copper, aluminum, zinc and nickel, hot sheets, cold sheets, tin plate and strip, merchant bars and rods, special machinery for the rolling mill industry, mill drives, Three High Mills, continuous bar and billet mills, cold mills for sheet and strip, shape straightener machines, motor operated screwdown for mills, gear sets, plate levelers, rail breakers, rail re-rolling mills, universal mill spindles, shears of all varieties, testing machines.

NATIONAL ALLOY STEEL COMPANY

Special alloy castings for service under severe conditions, creating savings in operations especially with regard to problems involving high temperature, corrosion and abrasion.

PITTSBURGH ROLLS CORPORATION

PHOENIX ROLLS: Phoenix steel for unusual strength, Phoenix "A" (steel alloy) for strength and wear; Phoenix metal—Phoenix "K" for strength, wear, and finish, Phoenixloy (uniformly hard) for flat rolling where high finish of extremely thin gage of material is required to be free from all marks and defects; also tube mill rolls of quality material best suited to the kind of service required. Phoenix Chill—Phoenix nickel chill for all flat rolling requiring finish.

UNION STEEL CASTING COMPANY

Spindles, coupling boxes and other steel mill castings of UNIVAN "C" to insure great strength and exceptional wearing qualities. Charging boxes made of tough UNIVAN alloy have longer life because of unusually high impact value.

POWER PIPING CORPORATION

Pipe systems prefabricated and erected. Prefabrication guarantees greater dimensional accuracies of sub-assemblies, few field joints to be tested, freedom from shutdown due to failure; also automatic sprinkler systems guaranteed to meet all insurance requirements.

NATIONAL ALLOY STEEL COMPANY,
Blawnox, Pa.

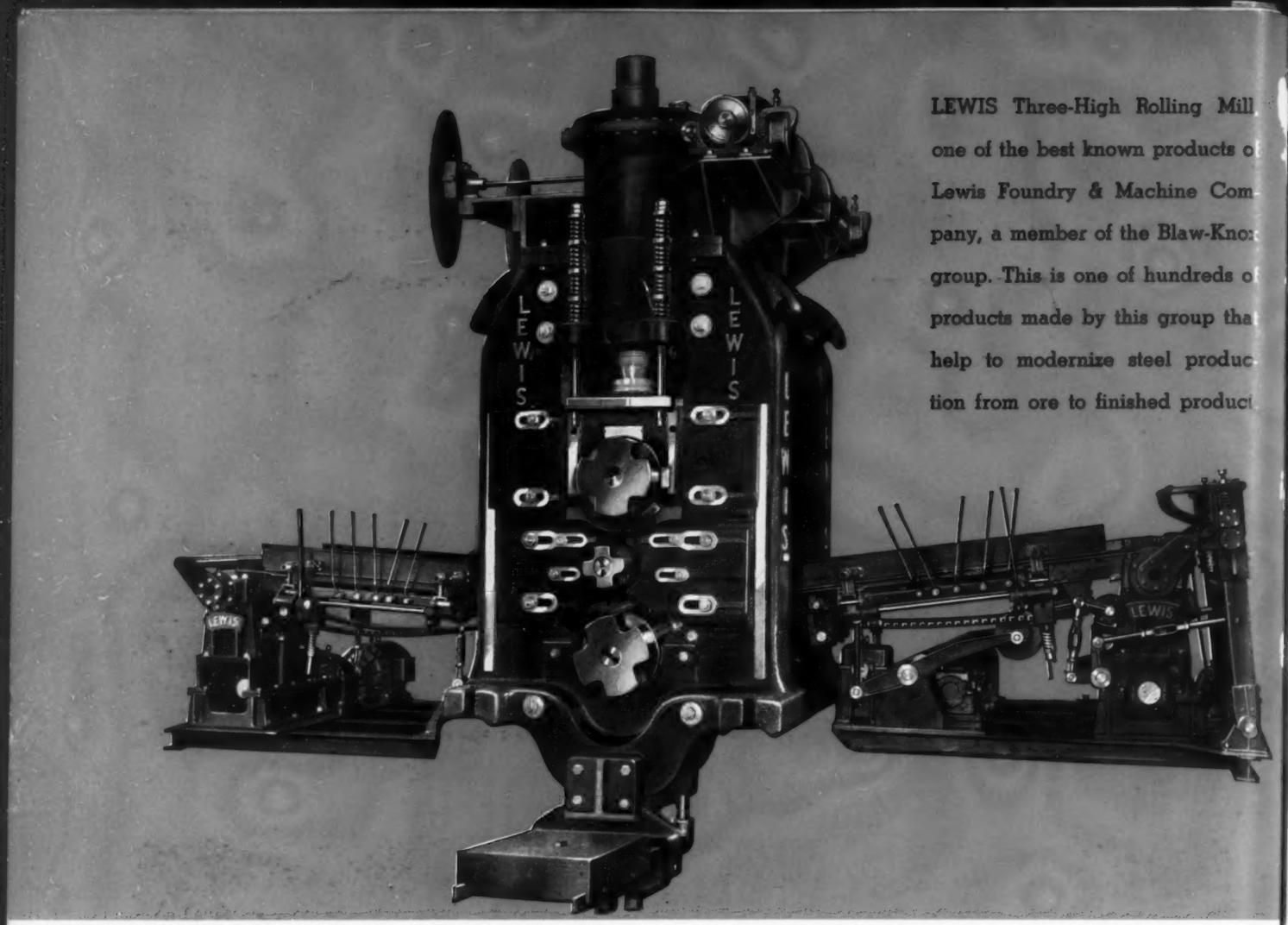
Specializes in the electric casting of alloys to meet steel plant problems of high temperature and corrosion. National Alloy mill equipment surpasses every expectation of long life.

POWER PIPING CORPORATION,
Pittsburgh, Pa.

Prefabricator of power piping in accordance with the most advanced engineering practice. Automatic sprinkler systems for fire protection.

UNION STEEL CASTING COMPANY,
Pittsburgh, Pa.

Produces an extremely durable line of castings under the trade name UNIVAN, combining nickel and vanadium with steel for greater strength and toughness under severe service conditions, as in the case of spindles, coupling boxes, charging boxes, etc.



LEWIS Three-High Rolling Mill, one of the best known products of Lewis Foundry & Machine Company, a member of the Blaw-Knox group. This is one of hundreds of products made by this group that help to modernize steel production from ore to finished product.

All are as one unit

"Blaw-Knox" is a two-word characterization of a service to steel that includes highly specialized knowledge, wide experience, and practical creativeness gathered into a single unit.

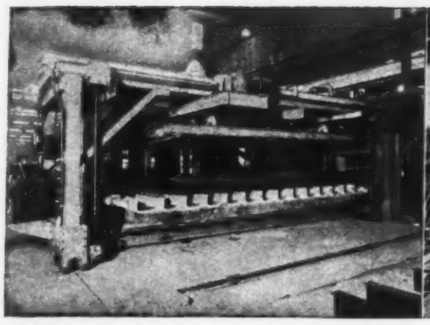
The companies composing this unit all operate as one to give to steel plant operators a "partner" whose joint facilities and experience are available to produce substantial economies of operation and substantial improvement of product.

Blaw-Knox engineers are as near as your telephone, always available to talk things over with and point out better ways of doing things if any be found.

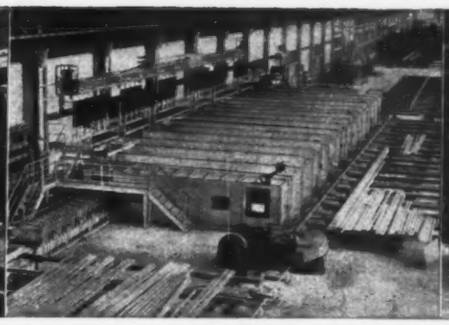
BLAW-KNOX
Steel's Partner

BLAW-KNOX CO., BLAWNOX, PA. · LEWIS FOUNDRY & MACHINE CO., PITTSBURGH, PA. · NATIONAL ALLOY STEEL CO., BLAWNOX, PA.
PITTSBURGH ROLLS CORP., PITTSBURGH, PA. · UNION STEEL CASTING CO. PITTSBURGH, PA. · POWER PIPING CORP., PITTSBURGH, PA.

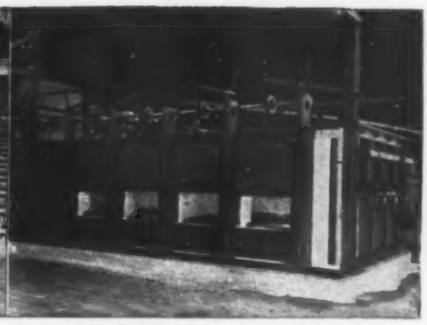
Pittsburgh - New York - Chicago - Philadelphia - Birmingham - London - Paris



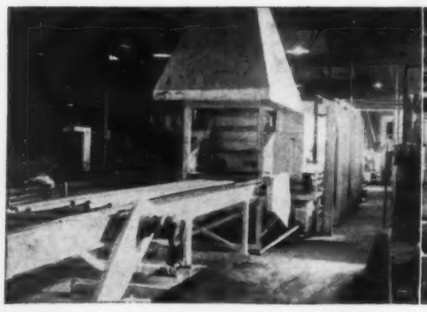
HEAT TREATING ALLOY STEEL BARS
—quench in background



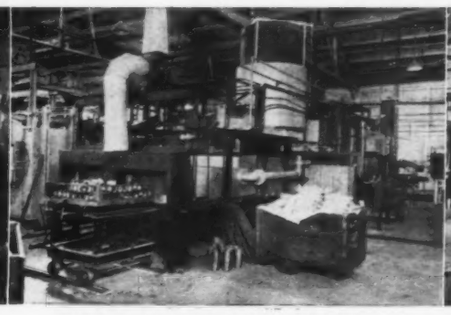
HEAT TREATING 90 FOOT LENGTHS
—uniformly and continuously



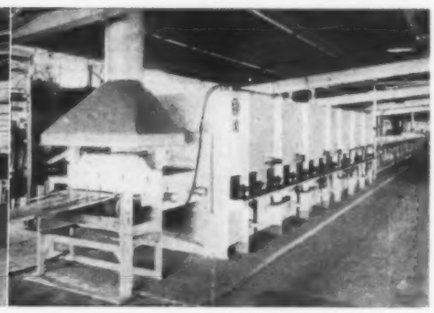
FUEL-FIRED BILLET HEATING FURNACES
—built in any size for oil or gas



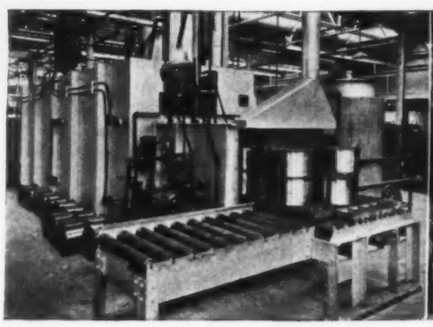
BRIGHT ANNEALING STEEL TUBING
—continuously—various lengths and diameters



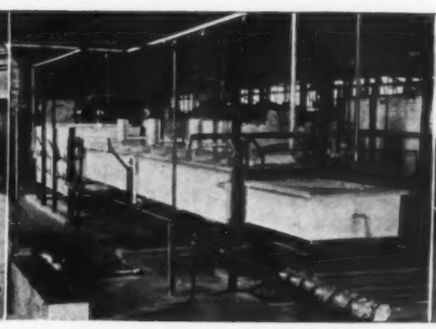
BRIGHT ANNEALING STAMPINGS
—continuously—ferrous and non-ferrous



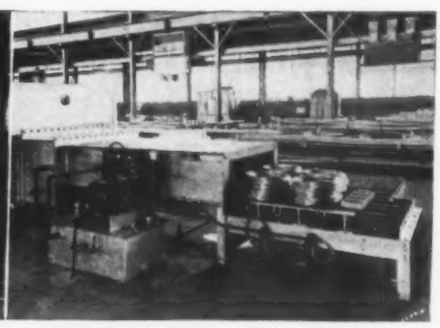
BRIGHT ANNEALING STEEL IN STRIP
—more uniform anneal and finish



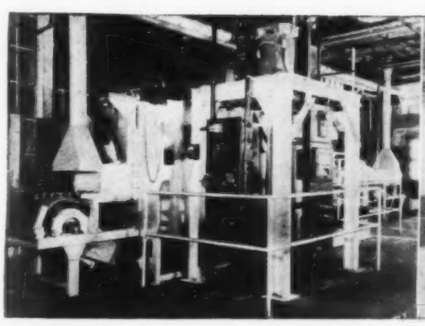
BRIGHT ANNEALING COPPER WIRE
—on large reels—36,000 lbs. per day



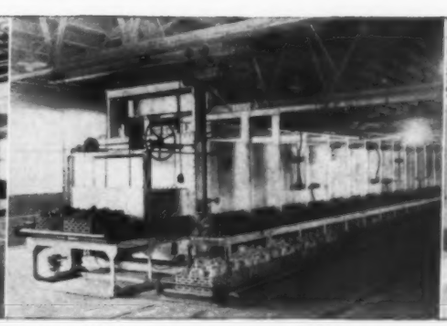
BRIGHT ANNEALING FINE WIRE
—on small spools—5 tons per day



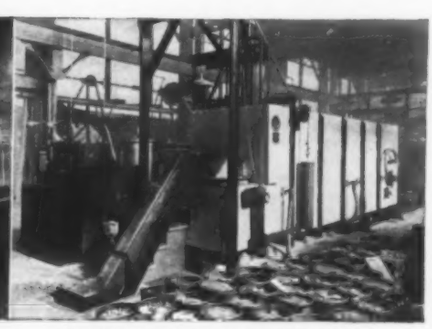
BRIGHT ANNEALING COILED WIRE
—Bronze, Copper, Nickel Silver, etc.



COPPER BRAZING STEEL ASSEMBLIES
—economically and continuously



CLEAN ANNEALING SHORT CYCLE
MALLEABLE CASTINGS



SCALE FREE HARDENING BOLTS
—in continuous chain belt furnaces—1000 lbs. per hr.

Some Electric and Fuel Fired Furnaces Designed and Built by

The Electric Furnace Co., Salem, Ohio

We Build Gas Fired and Electric Furnaces For Any Product, Process or Production

A PERMANENT Electrical Conduit—FOR SERVICE THAT'S REALLY TOUGH!

ELECTRICAL CONDUIT in steel-mill service must be able to meet the most rigorous of demands . . . and meet them with permanent efficiency.

It must offer thorough adaptability . . . assure effectiveness above ground or below . . . indoors or out . . . under a wide variety of severe service conditions.

Consider the suitability of Transite Conduit for such conditions. Strong enough to be laid without a concrete envelope, Transite Conduit eliminates concreting costs and thus effects major installation savings.

And Transite Conduit—an asbestos-cement product—is resistant to corrosion, immune to rot or decay . . . virtually free from maintenance throughout its long life.

Above ground—in all exposed locations—this durable material is incombustible, weatherproof and unharmed by smoke or most corrosive fumes. Hence you are assured of a conduit that permanently and economically safeguards your electrical distribution systems.

• • •

For complete information on Transite Conduit and Transite Korduct (described below), write to Johns-Manville, 22 E. 40th Street, New York City.

UNDERGROUND, Transite Conduit is so strong it needs no concrete envelope . . . hence assures important installation savings. And even under severe service conditions, its permanence assures years of virtually maintenance-free service.

ON ALL EXPOSED LOCATIONS, Transite Conduit provides continued economical service. Thoroughly adaptable, its durability, incombustibility and immunity to rot and decay, combine in making it the perfect answer to steel-mill conduit needs.

USE J-M KORDUCT FOR "CONCRETING-IN"

Possessing all the advantages of Transite Conduit . . . but offering lesser wall thickness . . . and lower cost . . . J-M Transite Korduct is the conduit to use on all duct systems where a concrete envelope is necessary. Korduct's light weight and long lengths sizably reduce both material and handling expense.

J-M TRANSITE KORDUCT on an 8-way duct line. Differing only in its lesser wall thickness (and therefore lower cost) from Transite Conduit, Korduct is also asbestos-cement in composition. Hence it assures the same durability and virtual freedom from maintenance throughout its many years of service.

MOVABLE ELECTRICAL OUTLETS

for FLEXIBLE LIGHTING ARRANGEMENTS

BULL DOG

UNIVERSAL TYPE

Trol-E-Duct

You are constantly making changes in your floor layout, machinery and equipment, so why not have a lighting system that permits your overhead lighting to be readily adjusted to conform to your floor layouts?

Every point of The Universal Trol-E-Duct Duct Run is a potential source for supporting and feeding lighting fixtures or small tools, which, if desired, can be moved freely in either direction along the Duct Run.

The many ADVANTAGES of this MOVABLE system, in contrast to the LIMITATIONS of the conventional FIXED or STATIONARY system, can be readily appreciated.

The movable, current carrying TROLLEY

Underneath view of DUCT in which Busbars are mounted and into which TROLLEYS are inserted.

Lighting Fixture attached to a TROLLEY which acts as both feeder and movable means.

Above photograph shows part of a complete factory overhead lighting installation of Bull Dog Universal Trol-E-Duct.

WRITE FOR ILLUSTRATED BULLETIN

Cross Sectional View, Showing Rolling TROLLEY Inserted In DUCT.

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Pioneers of Flexible Electrical Distribution Systems

DETROIT, MICHIGAN

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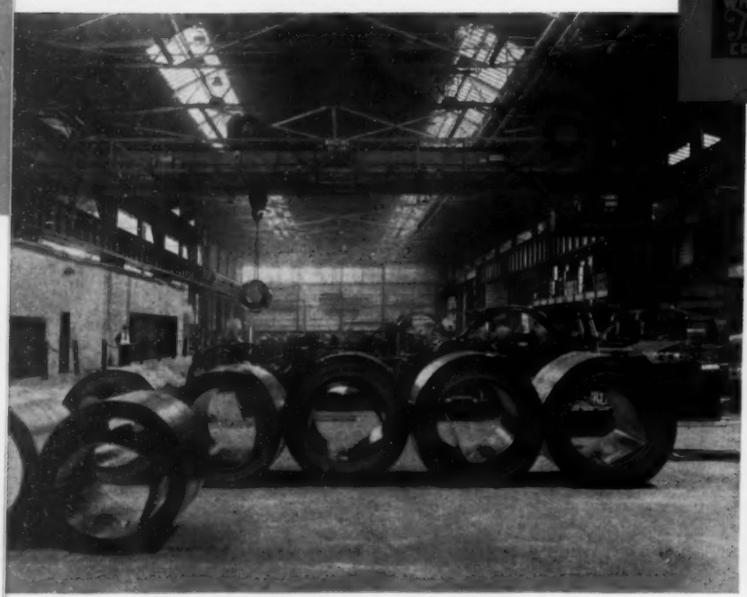
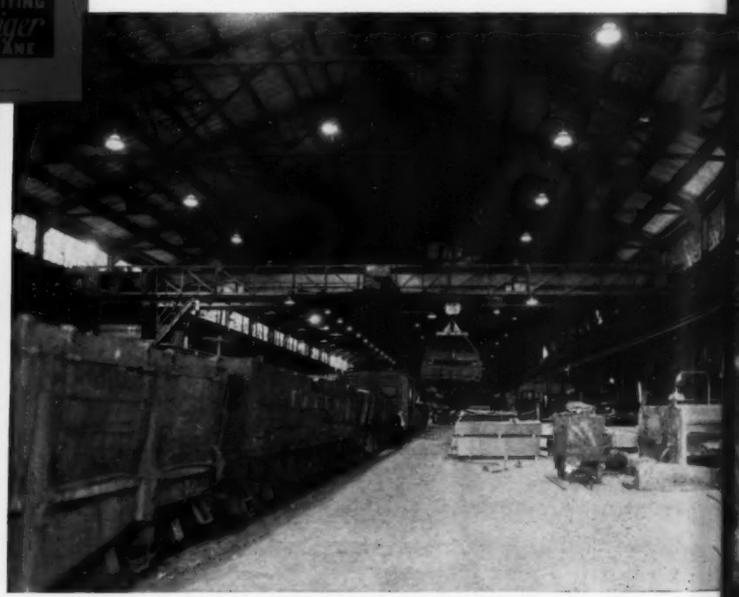
LOW-COST OVERHEAD HANDLING WITH TIGER ELECTRIC TRAVELING CRANE

15-ton, 120-ft. span, Whiting Steel Mill Crane in finishing department.

15-ton, 120-ft. span, Whiting Steel Mill Crane in finishing and shipping department.



20-ton, 90-ft. span, Whiting Steel Mill Crane in cold reduction department.



15-ton, 90-ft. span, Whiting Steel Mill Crane in hot strip finishing department.

Quick action, coupled with dependable low-cost operation make Tiger steel mill cranes the ideal overhead handling unit in any department of the modern steel mill. Continuous, speedy service, at a minimum of operating and maintenance cost, account for the Tiger's ready acceptance in the newest mills. Choose a Tiger for your next crane job.

Catalog No. 300 on request.

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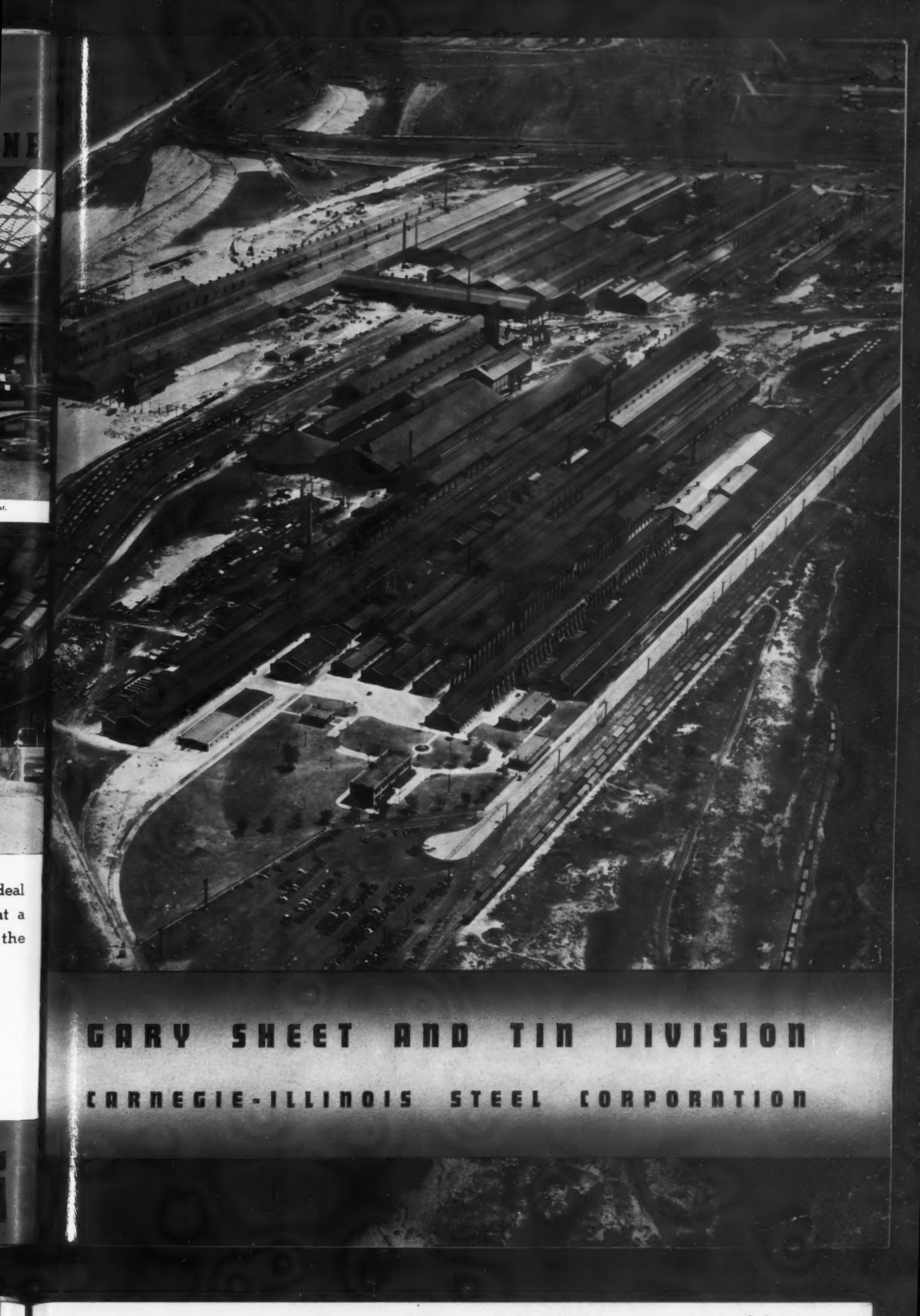

GARY SHEET AND TIN DIVISION
CARNEGIE-ILLINOIS STEEL CORPORATION

B. F. FAIRLESS
President
CARNEGIE-ILLINOIS STEEL CORPORATION

Carnegie-Illinois Steel Corporation

UNITED STATES STEEL CORPORATION SUBSIDIARY

General Offices: Carnegie Building
Pittsburgh, Pa.

B F FAIRLESS
PRESIDENT

August 28, 1937

Association of Iron and Steel Engineers,
Empire Building,
Pittsburgh, Pennsylvania.

Gentlemen:-

My associates join with me in welcoming you to Chicago for your 33rd Convention and Iron and Steel Exposition, to be held there September 28, 29, 30 and October 1. During its 30 years of existence the Association of Iron and Steel Engineers has worked hand in hand with the steel industry in the development of the industry's present position.

The important position of engineering in the steel industry only emphasizes the importance of cooperation with engineering activities.

The high plane upon which your exhibits have been maintained bespeak for them the attention and interest of all visitors. The technical discussions will be further contributions to the advancement of steel making and steel uses.

I feel sure that you will be impressed with your visit to the 80" hot strip mill at Gary, and sincerely trust that your visit to Chicago will not only be pleasant but successful in every respect.

I am Assuring you of our interest and pleasure of cooperating,

Sincerely,

B. F. Fairless

President.

GARY

SHEET AND TIN DIVISION

CARNEGIE-ILLINOIS STEEL CORPORATION

▲ THE past thirty years have witnessed the growth of the Chicago district steel producing facilities from something less than 10% to about 25% of the national tonnage capacity. A large proportion of this increase was contributed by the development of the Gary mills, those huge plants of the Carnegie-Illinois Steel Corporation which extend for a considerable distance along the southerly shore of Lake Michigan.

The Gary sheet and tin mills have received a goodly portion of the improvements going to make up a modernization program begun in 1930 in the corporation plants in the Chicago district. Perhaps the most important of these steps is the installation of an 80″ wide continuous strip mill in the sheet mill plant. This mill is housed in buildings approximately 300 ft. wide by 2200 ft. long, built on land on the shore of the lake. First concrete for the mill was poured on May 20th, 1935, and the first slab was rolled on March 4th, 1936.

The mill has a nominal rated capacity of 50,000 gross tons per month, but has made actual production rates up to 73,000 gross tons per month. It is designed to roll strip in widths of 22″ to 75″, and in gauges of No. 3 to No. 19. Production averages about 50″ in width by No. 13 gauge, in rimmed and killed steels of various chemistries, including pure iron, high carbon steels, and silicon-, manganese-, and copper-bearing steels.

SLAB YARD

Railroad cars bring slabs to the slab yard, which is a building 864 ft. long by 124′–9″ wide. It has a normal storage capacity of about 50,000 tons, but has accommodated up to 80,000 tons at times. It is served by two 30 ton cranes of 120 ft. span, with 10 ton auxiliary hoists and lifting magnet controls, and one 10 ton crane. Slabs are handled almost entirely by magnet through the slab yard and onto the magazine feeder with which each furnace is equipped. The bottom slab in the magazine is shoved over onto a skid type charging table for the furnace pusher. The distance from the magazine to the furnace door is 24′–7″. There are two pushers on each furnace, each driven by a 100 H.P., 475 R.P.M. compound D.C. motor. The pushers on each furnace can be operated individually or can be interlocked so as to operate as a single unit. Slab eveners are installed to insure good alignment of the slabs entering the furnaces. They are oil-operated at a pressure of 1500 ft. head. Furnace charging doors are operated by electrical thrustor units.

Slabs come to the mill in sizes as follows:

	Average	Max.	Min.
Slab width.....	40″	61″	22″
Slab thickness.....	5½″	7½″	4½″
Slab length.....	105″	216″	72″
Slab weight.....	9000 lbs.	18000 lbs.	2900 lbs.

HOT MILL FURNACES

There are three continuous pusher type furnaces, 80 ft. long x 20 ft. wide, each designed for a capacity of 60 gross tons per hour of cold slabs, 6″ thick x 60″ wide x 96″ long heated to 2250 degrees F. A soaking zone 16′–9″ long is incorporated in each furnace. The furnaces are fired with producer gas, in a triple zone layout. Six burners overfire the main heating chamber, while eight burners underfire it. The soaking chamber is overfired through eight burners. Maximum fuel input is given as 12000 lb. of coal (converted into producer gas) per hour per furnace (or about 120,000,000 B.T.U.).

Each furnace is equipped with a recuperator in which air for combustion is heated to temperatures averaging about 450 degrees F., with a maximum temperature of about 700 degrees F. Air is pulled through the recuperators by a motor-driven fan on each furnace, rated at 36,000 cu. ft. per min. at 700 degrees F., and 3½″ water column.

The furnaces are steel-cased. Flat suspended arch construction is used on furnace roofs, which are covered with 2½″ of insulation. Sidewalls and bottoms are constructed with insulation 4½″ thick.

Automatic control has been applied to maintain furnace pressure. Temperature of the air leaving the recuperator fans is also automatically controlled. Instruments have been applied to each furnace as follows: A four point recording pyrometer measuring flue gas temperature entering and leaving the recuperator, and air temperatures leaving the recuperator and the fan; gas pressure indicators for each of the three firing zones in the furnace; an indicator showing main air pressure; a recorder showing pressure in the soaking zone; indicating air flowmeters on each group of burners.

Flue gases from the heating furnaces are conducted through underground flues to individual stacks, or to a battery of two waste heat boilers. Valves of heat resisting metal permit the waste gases to be vented through either course as desired. Each boiler contains 10960 sq. ft. of heating surface and 450 sq. ft. of superheater surface, and produces steam at 200 lb. pressure and 150 degrees F. superheat. An induced draft fan, rated at 79800 cu. ft. per min., 6″ water column, and driven by a 150 H.P., 580 R.P.M. motor, is installed on each boiler. Two 156 G.P.M. centrifugal feed pumps are provided, one driven by a 50 H.P. turbine, the other by a 50 H.P. motor. Necessary water softening and heating equipment is also installed, as well as a complete layout of meters and instruments.

HOT MILL

Slabs, at temperatures averaging about 2200 degrees F., are discharged from the heating furnace by gravity, through action of the furnace pushers, and are brought up to the mill over a roller table 192 ft. long, sectionalized into four units each driven by a 65 H.P. stabilized shunt D.C. motor.

No. 1 scalebreaker is located 41′–3″ from the nearest furnace. This unit is a 2-high, 32″ x 80″ stand, driven through a 22.08:1 ratio gear set, with a 12′–6″ flywheel, by a 1250 H.P., 6600 volt, 514 R.P.M., 3 phase, 60 cycle wound rotor induction motor.

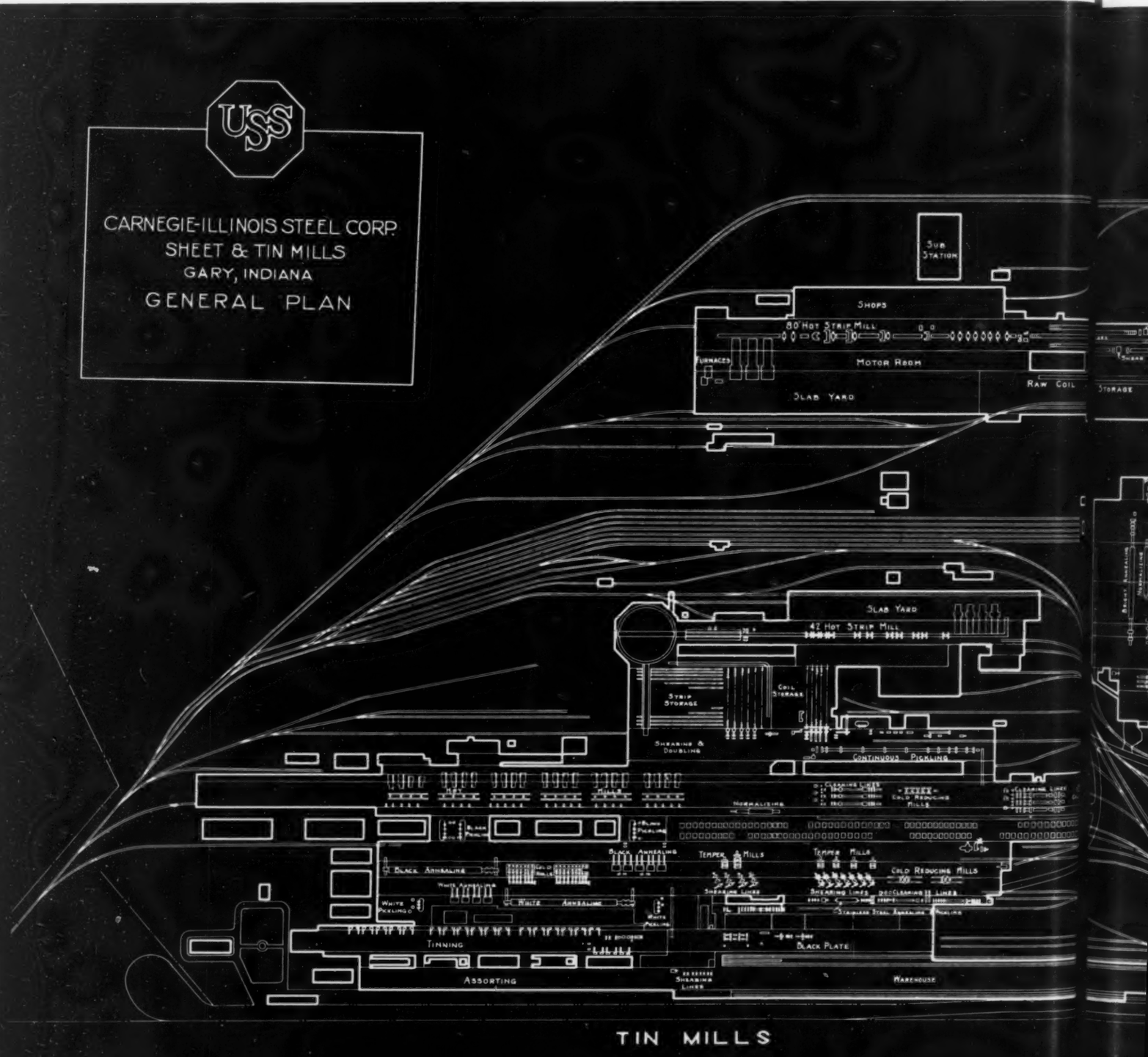
Following this, at a distance of 26 ft., is a 4-high broadside mill, 40″ and 54″ x 130″, driven through a 19.54:1 gear set with 15′–6″ flywheel by a 3500 H.P., 6600 volt, 356 R.P.M. wound rotor induction motor. Slabs up to 125″ in length may be cross-rolled in this stand in order to obtain strip widths greater than those of the slabs originally supplied. To turn the slabs into position for cross-rolling and then restore them to their original axis, a turntable, driven by two 33 H.P., 625 R.P.M. compound D.C. motors, is installed in each side of the broadside mill. To insure proper entry of slabs into the broadside mill a slab pusher is installed. It is driven by a 65 H.P., 535 R.P.M. stabilized shunt wound motor. Following the broadside mill, a slab squeezer serves to true up slab edges and width, and to flatten out the slab for subsequent rolling. The squeezer main drive consists of a 300 H.P., 2200 volt, 439 R.P.M. wound rotor induction motor. Squeezer

G. C. KIMBALL,
Executive Vice President

adjustments are made through two 33 H.P., 625 R.P.M., 250 volt D.C. motors, while the squeezer table is driven by a 65 H.P., 535–1040 R.P.M. stabilized shunt wound motor. A slab shear is located at the exit of the squeezer.

The second roughing stand, which is spaced 45 ft. beyond the broadside mill, is a 2-high, 42″ x 80″ mill. This is rather unusual, as most of the strip mills employ a 4-high stand at this point. No. 3 rougher, 63 ft. farther on, is a 4-high, 26″ and 53″ x 80″ stand, as is No. 4 rougher, which is 94 ft. distant from No. 3. All three of these roughing stands are driven through gear sets, with 12′–6″ flywheels, by 3500 H.P., 6600 volts, 509 R.P.M. wound rotor induction motors.

Immediately proceeding No. 2, 3, and 4 roughing stands are separate vertical edging stands. Edging rolls in these stands are respectively 32″ x 10¼″, 32″ x 5½″, and 24″ x 3½″. Each stand is driven by a

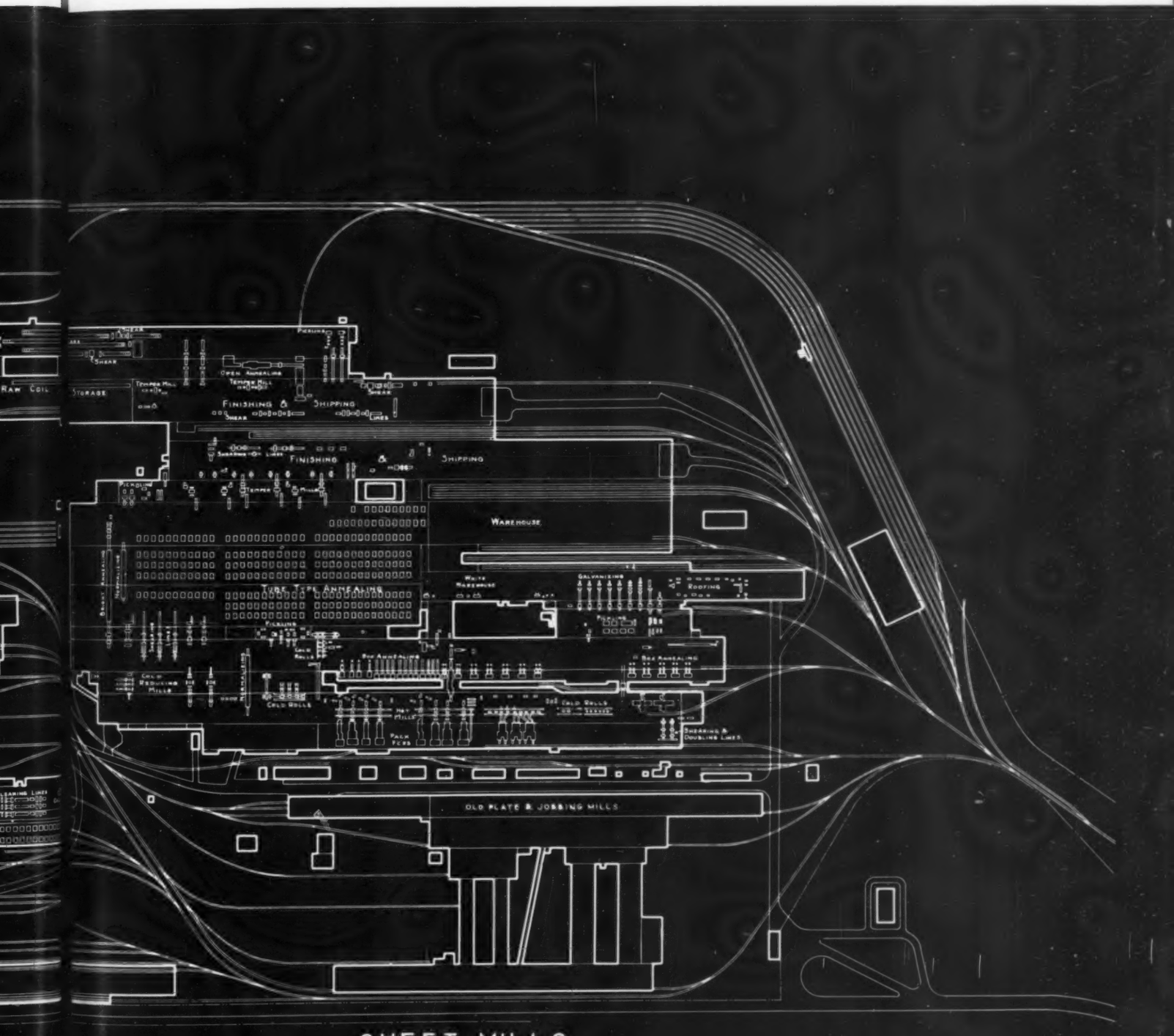


350 H.P., 230 volt, 400-800 R.P.M., D.C. motor.

A cooling table 210 ft. long lies between the roughing and finishing trains. No forced cooling system has been installed on this table, although grids have been provided for a future cooling system, if and when required. A crop shear is also installed between the roughers and finishers.

No. 2 scalebreaker is a 2-high, 36″ x 80″ stand, driven by an 800 H.P., 600 volt, 150-450 R.P.M., D.C. motor.

The six finishing stands are all 4-high, 26″ and 53″ x 80″. They are each driven by a 4500 H.P., 600 volt, D.C. motor, except the last stand, which has a 3000 H.P. motor. No. 5, 6, and 7 stands are driven through gear sets, with motor speeds of 125-282 R.P.M., while No. 8, 9, and 10 stands are driven direct, at motor speeds of 85-190, 100-230, and 110-255 R.P.M. respectively. All finishing stands are located on 22 ft. centerline spacing.



SHEET MILLS

Gear ratios and mill speeds in this mill are as follows:

	Gear Ratio	Roll Speed, R.P.M.	Strip Speed Ft. per Min.
No. 1 Scalebreaker	22.08	23.2	194
Broadside Mill	19.54	18.2	190
No. 1 Edger	39.2	20.4	85–170
No. 2 Rougher	26.8	19.0	208
No. 2 Edger	25.6	31.2	96.7–193.5
No. 3 Rougher	10.54	48.2	326
No. 3 Edger	10.59	75.5	315–630
No. 4 Rougher	7.48	68	464
No. 2 Scalebreaker	17.75	84.5–253.4	80– 240
No. 5 Finisher	4.25	29.4– 66.4	200– 450
No. 6 Finisher	2.75	45.4–102.8	306– 694
No. 7 Finisher	1.9	65.9–148.2	448–1000
No. 8 Finisher	Direct	85–190	578–1290
No. 9 Finisher	Direct	100–230	680–1562
No. 10 Finisher	Direct	110–255	750–1735

There are six loopers, one located ahead of each finishing stand. They carry idle rolls, and are operated by manually controlled air cylinders.

Screwdown drives are mounted on top of the mill housings, and are of the following ratings:

No. 1 Scalebreaker—One 45 H.P., 550 R.P.M., 250 volt compound motor.

No. 1 Broadside—One 65 H.P., 550 R.P.M., 250 volt compound motor.

No. 2 Rougher—One 45 H.P., 550 R.P.M., 250 volt compound motor.

C. F. DICKINSON,

Assistant to General Superintendent

No. 3 Rougher—Two 45 H.P., 550 R.P.M., 250 volt compound motor.

No. 4 Rougher—Two 45 H.P., 550 R.P.M., 250 volt compound motor.

No. 2 Scalebreaker—One 45 H.P., 550 R.P.M., 250 volt compound motor.

No. 5, 6, 7, 8, 9, and 10 Finishers, each—Two 75 H.P., 500 R.P.M., 250 volt compound motors.

On stands employing the dual drives, the two drives are connected together through magnetic clutches.

Babbitt bearings are used on the two scalebreakers, and on the 2-high No. 2 roughing stand. The broadside mill is equipped with roller bearings on the work-rolls, and composition bearings on the back-up rolls. Roller bearings are employed on both work rolls and back-up rolls of the last two roughing stands and all finishing stands.

Devices for measuring and indicating roll pressures are installed on all mill stands except the scalebreakers.

Strip temperature is watched carefully throughout its passage through the mill. Four photo-electric pyrometers measure temperatures at various points, which are chartered on two recorders. There are also five indicating portable radiation pyrometers.

Roll balance is accomplished through oil-hydraulic systems, of which there are three installed, each with a circulating capacity of 4 G.P.M. at 1850 lb. pressure, motivated from 7/8″ x 4″ triplex pumps. Soluble or vapor oil is employed in these systems.

A typical schedule of reductions made on the steel through each pass follows:

Slab, 4.84″ x 37″ x 72″. Rolling size, .0903″ x 37″.

	Per Cent Reduction
No. 1 Scalebreaker	16
Broadside Mill	28
No. 2 Rougher	36
No. 3 Rougher	36
No. 4 Rougher	36
No. 5 Finisher	49
No. 6 Finisher	40
No. 7 Finisher	39
No. 8 Finisher	33
No. 9 Finisher	13
No. 10 Finisher	12

To remove scale from the slab and insure good surface on the finished strip, hydraulic descaling sprays are located at the exits of No. 1 scalebreaker, No. 2, 3, and 4 roughers, and No. 2 scalebreaker. The sprays on both scalebreakers and on No. 3 rougher are used practically all of the time steel is passing through these stands, while the others are used only when conditions require it. Water is supplied to these sprays from six centrifugal pumps, each of 1000 G.P.M. capacity, three of which operate at 650 lb. pressure and three at 1300 lb. pressure. Each pump is driven by a 600 H.P., 1770 R.P.M., A.C. motor. There are also four centrifugal pumps, each of 3000 G.P.M. capacity at 45 lb. pressure, driven by 100 H.P. motors, to supply water to the high pressure pumps. Two more centrifugal pumps, 1500 G.P.M. at 300 lb. pressure, driven by 400 H.P. motors, supply water for scale flushing.

J. M. DARBAKER,
General Superintendent

Water consumption for the hot mill is said to be 17600 gallons per minute, with about an equal amount being used by the rest of the plant. Water is pumped to the mill from a pumping station located on Lake Michigan, from whence the water is drawn.

MILL TABLES

A complete synopsis of the mill tables follows:

No. 1 Scalebreaker to Broadside Mill—Driven through gear reduction, line shaft and bevel gearing by a 45 H.P., 250 volt stabilized shunt motor, controlled by a resistance step starter.

Broadside Mill to Squeezer—Same as preceeding.

Squeezer to Slab Shear—Driven through gear reduction, line shaft and bevel gearing by a 65 H.P., 250 volt, 525 R.P.M. compound motor, controlled by resistance step starter.

Slab Shear to No. 2 Rougher—Same as preceeding.

No. 2 Rougher to No. 3 Rougher—Driven through gear reduction, line shaft and bevel gearing by a 65 H.P., 535-1070 R.P.M. stabilized shunt motor, with speed control through field rheostat.

No. 3 Rougher to No. 4 Rougher—Same as preceeding.

Cooling Table, No. 4 Rougher to No. 2 Scalebreaker—Two sections, each driven through gear reduction, line shaft and bevel gearing by a 65 H.P., 250-1000 R.P.M. stabilized shunt motor, controlled by a resistance step starter, with speed control through field rheostat.

Table Ahead of No. 2 Scalebreaker—Driven by five special individual induction motor drives, 47.5-190 volts, 5.4-21.6 cycle, 3 phase, 23.2-98.8 R.P.M.

No. 2 Scalebreaker to No. 5 Finisher—Driven by four special individual drive induction motors, 47.5-190 volts, 5.4-21.6 cycle, 25-100 R.P.M.

No. 5 Finisher to No. 6 Finisher—Driven by four special individual drive induction motors, 47.5-154 volts, 5.4-17.5 cycles, 46-150 R.P.M.

No. 6 Finisher to No. 7 Finisher—Driven by four special individual drive induction motors, 47.5-154 volts, 5.4-17.5 cycles, 65-210 R.P.M.

No. 7 Finisher to No. 8 Finisher—Driven by four special individual drive induction motors, 47.5-154 volts, 5.4-17.5 cycles, 108-350 R.P.M.

No. 8 Finisher to No. 9 Finisher—Driven by four special individual drive induction motors, 147-440 volts, 20-60 cycles, 200-600 R.P.M.

No. 9 Finisher to No. 10 Finisher—Driven by four special individual drive induction motors, 147-440 volts, 20-60 cycles.

The speed of the individually driven rollers through the finishing train is controlled by varying the speed of the driving motor of the variable frequency motor-generator sets, described elsewhere in this article.

Centrifugally cast, smooth surfaced alloy iron rolls are used in all of the foregoing tables. Between the roughing stands, the rollers are equipped with tapered roller bearings on one end and straight roller bearings on the other end. Between the finishing stands, straight bearings are used on both ends.

Leaving the finishing train, a center run-out table 587 ft. long carries the strip from the mill. Additional cooling tables are on each side of the center table, 529 ft. and 568 ft. in length, respectively. Two chain drag type transfers serve to convey the strip from the center table to either of the side tables. The rollers in

Slabs up to 125" in length may be cross-rolled in this 4-high broad-side mill in order to obtain strip widths greater than those of the slabs originally supplied.

J. E. ANGLE,
Assistant General Superintendent, Sheet Mills.

these tables are of centrifugally cast iron, with smooth surface, and are equipped with self-aligning roller bearings on both ends. They are individually driven by 782 induction motors, 147-440 volts, 3 phase, 20-60 cycles, of the following sizes and speeds:

136 motors—1.6-5 H.P., 194-583 R.P.M.
170 motors—.5-1.5 H.P., 180-580 R.P.M.
476 motors—.3-1.0 H.P., 52.5-157 R.P.M.

In the center run-out, at the exit of No. 10 finishing stand, is located a hot flying shear, which can gauge lengths from 11 ft. to 35 ft. It is driven by two 150 H.P., D.C. motors which receive their power from an individual motor-generator set. The speed of this shear is controlled by a synchronizing device on No. 10 stand.

About 300 ft. farther along the center run-out there are two coilers, each driven by eight individual roll motors, 5-15 H.P., 147-440 volts, 20-60 cycles, 225-705 R.P.M., with a bottom pinch roll drive of 1.67-5.0 H.P., 173-580 R.P.M. Coils are ejected from the coilers by air operated pushers, up-ended, and conveyed on end into the coil storage department.

Each side run-out table contains a flying cold shear, with length ranges of 96″ to 245″, driven by a 150 H.P. shunt motor. The motors are controlled by resistance step starters, with field control through hand operated field rheostats for controlling cut lengths. One of these shears employs a change gear box, while the other uses a hydraulic speed changing unit.

Located in the end of the run-out building is the necessary equipment for finishing hot-rolled flat products, including temper mills, resquaring shears, trimming lines, an open annealing furnace, and pickling equipment.

The hot mill building is 94′–9″ wide by 2208′ long, and is provided with three 60 ton cranes, with 10 ton auxiliary hoists, 90 ft. span.

A building 94′–9″ wide by 624′ long, conveniently located alongside the hot mill, houses service shops and roll shop. The latter includes two 60″ roll lathes, a 60″ roll grinder, two 36″ roll grinders, and a special degreasing machine for cleaning bearings, and is served by a crane of 90 ft. span, with 60 ton main hoist and 10 ton auxiliary hoist.

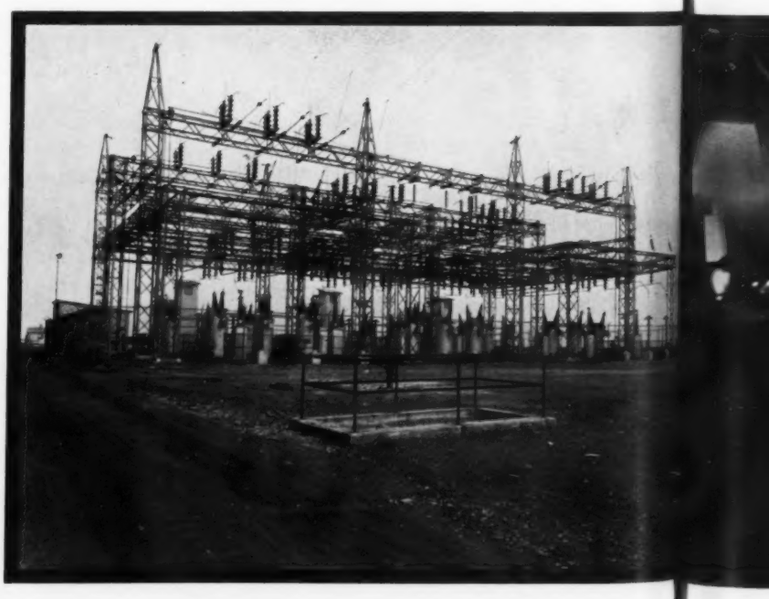
OUTDOOR SUBSTATION

Electric power for this mill is purchased, being supplied by the utility company at 132000 volts, 60 cycles, through two circuits on a steel tower line. This power is stepped down in an out-door substation located just outside of the building housing the service shops, through three transformer banks, each of 15000 K.V.A. capacity, 132000/6600 volts. The two circuits are fed from separate sections of the power company's substation to insure uninterrupted service.

Each line and transformer bank is protected by an oil circuit breaker, and in addition, one spare breaker is provided which can be used to replace any one of the five service breakers. Six pole gang operated disconnecting switches are provided to isolate all oil circuit breakers, and by-pass switches are used to connect all lines and transformer banks to the auxiliary bus. The station contains both a main and an auxiliary bus, the latter being used when the spare breaker is substituted for one of the service breakers during inspection.

As a safety feature, sectionalizing switches are pro-

Outdoor substation for stepping down purchased power. There are three transformer banks, each of 15,000 K.V.A. capacity, 132000/6600 volts.



vided in each bay, in both main and auxiliary bus. This makes it possible to sectionalize a complete bay, disconnecting the line and grounding it so that it is permissible to work at any point on the bay without interrupting service to the other two transformer banks. For additional safety, the disconnecting switches are interlocked so that they cannot be opened without first opening the breaker, and the sectionalizing switches are interlocked so they cannot be opened under load.

In operation, directional overcurrent relays are used for the balanced phase fault protection of the parallel 132000 volt incoming transmission lines. The overcurrent winding is connected in the differential circuit of cross connected current transformers, and receives no current in case of load or through faults. During a fault within the relay's own line section, a large differential current flows through the overcurrent element, and the faulty line is selected by means of the directional element. For ground fault protection directional relays are employed, using a standard connection.

These relays offer protection only during parallel line operation, and are rendered inoperative for single line operation. For protection during single line operation additional relays with appropriate time characteristics are provided.

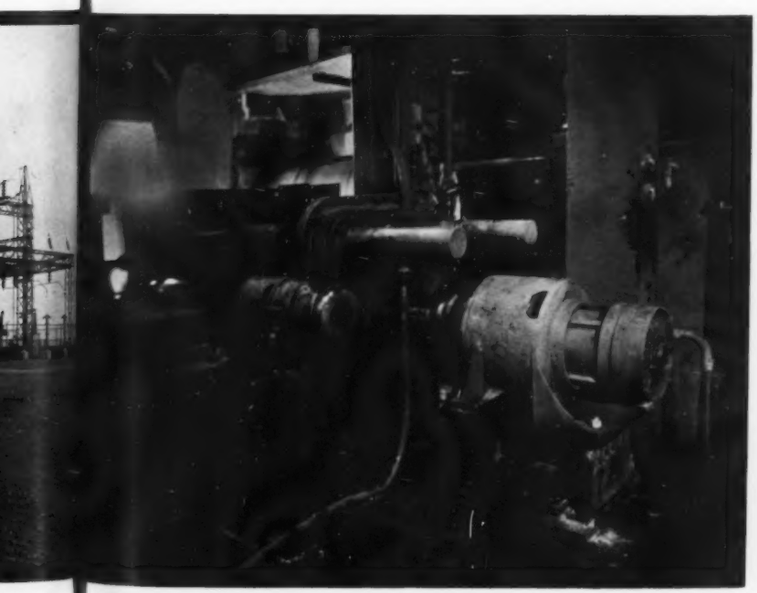
While the breaker is arcing to clear a fault, one phase will usually clear approximately one cycle ahead of the other two phases. Since the relays will operate in one cycle, undesired tripping of the breaker on the good line may occur. To prevent this undesired operation, the high speed auxiliary switches on the faulty line breaker operate to open the trip circuit on the good line breaker before the breaker on the faulty line starts to arc.

Differential relays are used to isolate promptly a transformer bank which may develop internal trouble. Protection is also afforded by relays when the transformer bank breaker is out of service and the bus tie emergency breaker is being used.

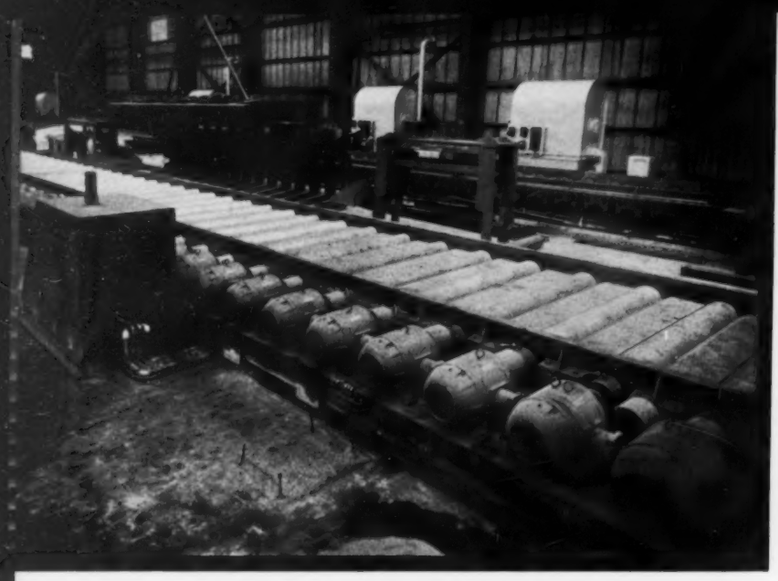
The low tension arrangement from the substation to the mill is unique. The leads are carried direct to concrete shafts which drop into a tunnel underneath

L. B. LANDON,
Assistant General Superintendent, Tin Mills.

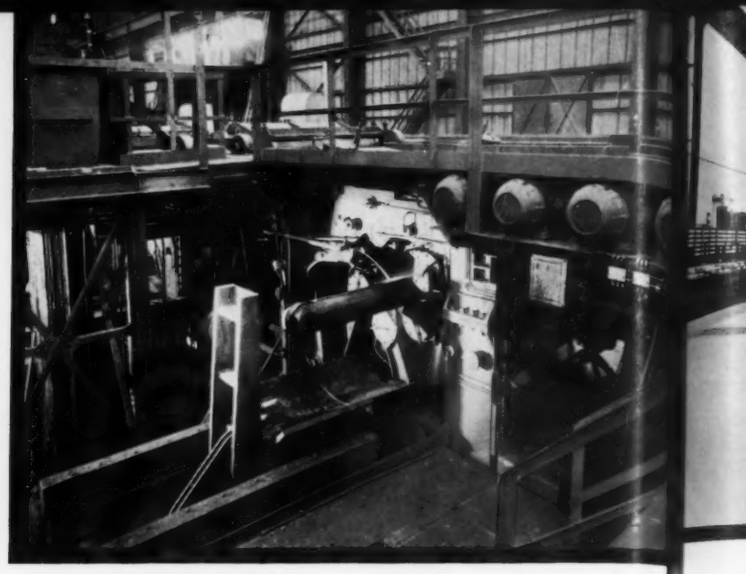
Gear motor with a. c. fan cooled motor unit driving table rolls ahead of scalebreaker on 80" hot strip mill.



Six 4-high finishing stands on the 80" mill. All finishing stands are spaced on 22 foot centerline spacing.

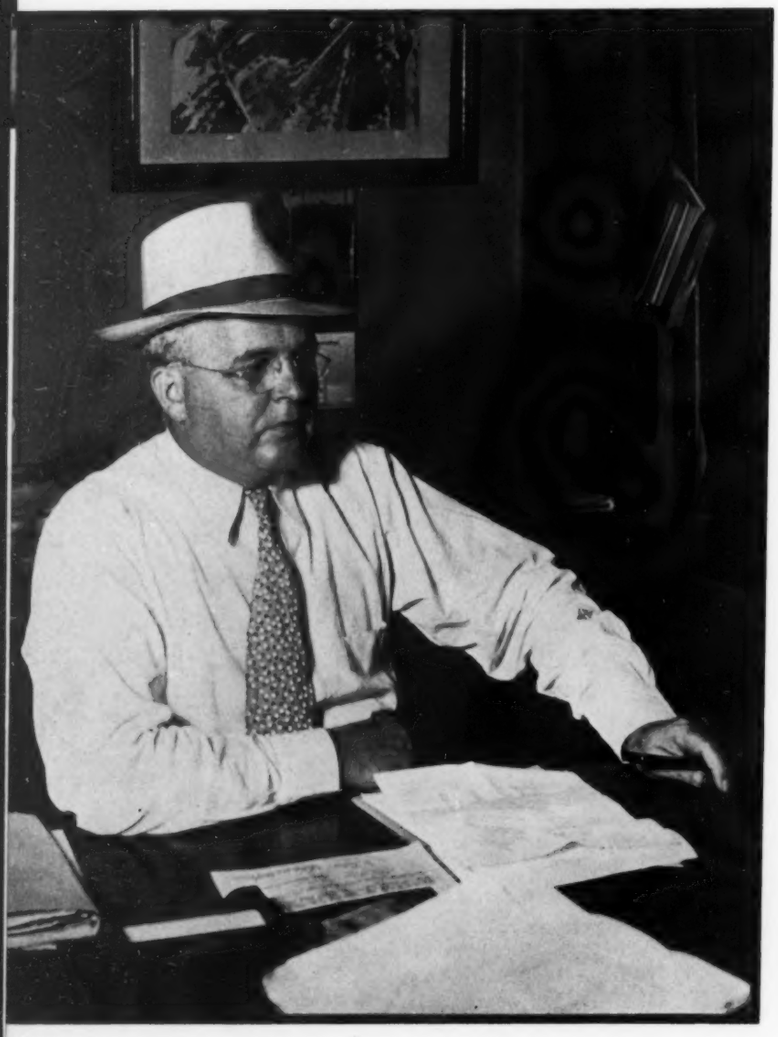


Center run-out table for conveying the strip from the last finishing mill stand. This center run-out table is 587 feet long.



About 300 feet from the flying shear are located two coilers each driven by eight individual roll motors. Coils are ejected from the coilers by air operated pushers.

W. GUY HOFFMAN,
Chief Engineer, Sheet and Tin Mills



the station where the low tension leads are carried in metal-clad to the indoor bus structure.

ELECTRICAL EQUIPMENT

Two auxiliary transformer banks, each consisting of three 500 K.V.A., 6600/220 volt transformers, supply power to auxiliary motors, while lighting circuits are served through fifty-five single phase 25 K.V.A., 6600/-110 volt transformers. Pumps, air compressors, etc., receive power at 2200 volts through a single bank of three 1500 K.V.A., 6600/2200 volt transformers.

A summary of 6600 volt connected load will be given on page nineteen.

An idea of the great amount of electrical machinery in this mill may be obtained from the following:

	Number	Total H.P.
Motors—80″ Hot Strip Mill	1665	95778
Generators—80″ Hot Strip Mill	29	33700
Total Hot Mill	1694	129478
Motors—80″ Finishing and Cold Mills	485	26526
Generators—Finishing and Cold Mills	23	20996
Total Finishing	508	47522
Grand Total	2202	177000

All rougher motors are of wound rotor induction type, and are controlled from the roughing pulpit. No. 1 scalebreaker and No. 3 and 4 roughers are started by means of an automatic secondary resistance step starter, while No. 1 broadside and No. 2 rougher are started by means of a slip regulator automatic starter.

Finishing mill motors are controlled from the finishing pulpit, and their speed is controlled by motor driven field rheostats and hand-operated vernier rheo-

Motor room for 80" continuous hot strip mill. The room is ventilated by forced draft with air filtered through three filters of the oil screen type.

Delivery end of No. 5 tandem mill in the temper mill department. There are five other single stand temper mills in this department.

stats. These motors are all started at the same time by the Ward-Leonard reduced voltage system, and are brought up to speed by raising generator voltage. The control is fully automatic, and is interlocked to prevent faulty operation. High speed breakers, with a current rate of rise trip feature, are used for D.C. motor protection. Power for the finishing stands is furnished from three dual motor-generator sets, each consisting of two 3000 K.W., 600 volt D.C. generators driven at 360 R.P.M. by a synchronous motor, 8650 H.P., 6600 volts. Excitation for the motors and generators is provided by a 500 K.W., 250 volt D.C. generator driven by a 715 H.P., 2300 volt, 900 R.P.M. synchronous motor.

D.C. power at 250 volts for auxiliaries comes from three 1000 K.V.A. motor-generator sets located in the hot mill motorhouse, and two of the same size located in the cold reduction department.

Variable frequency sets are installed as follows:

Seven 70/200 K.V.A., 147/440 volts, 20/60 cycle generators, each driven by a 100/150 H.P., 230 volt, 400/1200 R.P.M., D.C. motor, for coilers and shearing line tables.

Three 167/500 K.V.A., 147/440 volt, 20/60 cycle generators, each driven by two 125/150 H.P., 300 volt, 300/900 R.P.M. motors, for tables. These motors are connected in series, and take their power from the 600 volt D.C. mill bus.

Two 5/20 K.V.A., 110/440 volt, 15/60 cycle generators, each driven by a 15/20 H.P., 230 volt, 450/1800 R.P.M., D.C. motor, for tables.

Two 9.4/37.5 K.V.A., 47/190 volts, 5.4/21.6 cycle generators, each driven by a 25/30 H.P., 230 volt, 162/648 R.P.M., D.C. motor, for tables.

Selsyn units are used on signal systems connecting the operating pulpits with the coilers, No. 10 mill stand with the coiler pits, and the hot bed with the shear pulpits.

All large electrical units are cooled by forced draft from motor driven blowers. Three blowers are used on the roughing motors, while each main drive motor on the finishing train has a separate blower. Each of the three 6000 K.W. motor generator sets uses three

L. S. DAHL,
Superintendent, Hot Strip Mills, Sheet and Tin Mills

blower units, while the squeezer motor, and each edger motor has one blower. The motor room, which is 64′–9″ by 744′, is also ventilated by forced draft, with air filtered through three filters of the oil screen type and cooled in four radiator type air coolers with water circulation. A 50 ton crane, with 60 ft. span, is installed in the motor room.

LUBRICATION

Latest types of automatic lubrication equipment are used throughout the mill. Details of the various units are set forth in the accompanying lubrication chart. Pinion stands on the roughers and finishers are lubricated by individual pumps on each stand, as are screwdowns on the roughing mills.

PICKLING

The conveyors previously mentioned, which carry coils away from the coilers, deposit them on another conveyor which runs along the north wall of the raw coil storage building. This building is 124′–9″ wide by 720′ long, and is equipped with three 15 ton cranes of 120′ span, with lifting magnet controls.

Running south, at right angles to the coil storage, is the continuous pickling building, which houses four continuous pickling lines, of nominal rated widths of 84″, 72″, and two units of 36″. Each line consists of three acid tanks, one cold water tank, and one hot water tank, and is preceded by the usual uncoiler, pinch rolls, stitchers, and looping pit, and followed by dryers, shears and re-coilers. All pickling tanks are 60 ft. in length and 4 ft. deep. Tank widths are 8 ft.,

LUBRICATION TABLE 80″ HOT STRIP MILL
OIL SYSTEMS

No.	Type of System	Storage Capacity Gallons	Rate of Circulation G.P.M.	Grade of Oil	Oil Life	Oil Consump. Bbls./Month	Equipment Lubricated
1	Automatic circulating system	10,000	350	Heavy	Centrifuged weekly	18	Roughing mill reduction gears and pinion stand bearings. Edger drives. Squeezer drives. Slab shear and crop shear drives. Edger gears and bearings.
2	Automatic circulating system	6,000	60	Heavy	Centrifuged bi-weekly	7	
3	Automatic circulating system	3,000	90	Heavy medium	Original Oil	2	Motor bearings in motor-room and outboard bearings on finishing drives.
4	Automatic circulating system	3,000	90	Heavy medium	Original Oil	1	Pumps and pump drives in pump room.

GREASE SYSTEMS

No.	Type of System	Grade of Grease	Number of Bearings Serviced	Equipment Lubricated
1	Automatic mechanical centralized system.....	Medium	779	Slab return table, slab pusher, table bumper and delivery tables No. 1, No. 2, and No. 3.
2	Automatic mechanical centralized system.....	Light	760	No. 1 scalebreaker, No. 5 table, slab pusher, broadside mill, No. 6 table, squeezer, No. 7 table, slab shear, No. 8 table, shear gauge, No. 1, No. 2, and No. 3 edgers, and No. 2, No. 3, and No. 4 roughers.
3	Automatic mechanical centralized system.....	Light	861	No. 11 and No. 12 tables, crop shear, No. 2 scale breaker, No. 5, 6, 7, 8, 9 and 10 finishing stands and tables.
4	Automatic mechanical centralized system.....	Medium	462	Runout table No. 19, sheave wheel bearings and 8 rolls at shear.
5	Automatic mechanical centralized system.....	Medium	2500	Coil conveyors from coilers to east and west conveyors.
6	Automatic mechanical centralized system.....	Medium	2000	East coil conveyors.
7	Automatic mechanical centralized system.....	Medium	2320	West coil conveyor.
8	Automatic mechanical centralized system.....	Medium	449	Coilers, No. 19 table east of coilers and piles.
	Hand pump.....	Light	96	Slab furnaces.
	Motor-driven pump.....	Medium	629	No. 10 Runout table.
	Motor-driven pump.....	Medium	732	Roller leveller and runout table.

Grease Consumption Averages: 10 barrels medium per month; 45 barrels light per month.

H. E. GUDE,
Superintendent, Cold Reduction Department, Sheet Mill

I. J. PAUL,
Assistant Superintendent, 80″ Hot Strip Mill

CARL E. MOORE,
Superintendent, Cold Reduction Department, Tin Mill

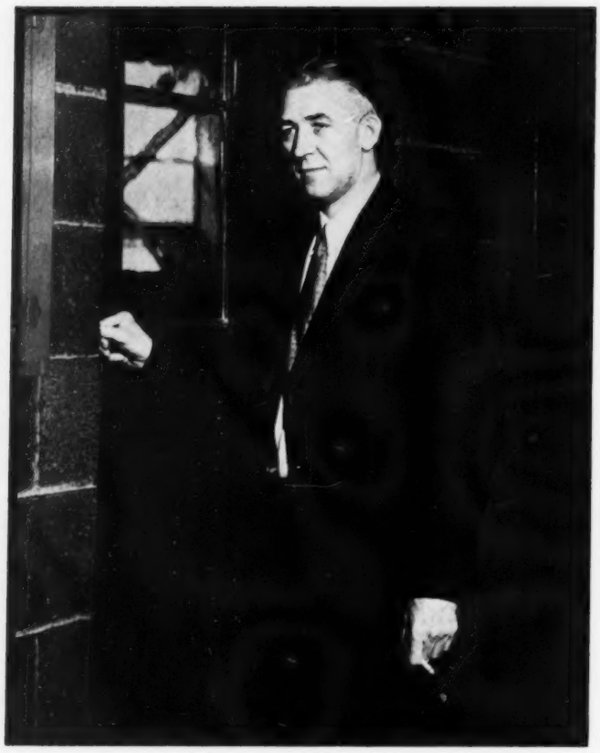
7 ft., and 4 ft. respectively for the three nominal sizes given above, and each tank contains respectively 14400 gallons, 12600 gallons, and 5400 gallons of solution. The tanks are of steel plate construction, rubber lined, with an inner lining of vitrified brick laid in a special bonding material. Tank covers are of steel plate, rubber lined, and are vented to the outside. An exhauster fan on each tank insures removal of the fumes, which then pass through a washer to remove excess acid. Pickling solutions are normally 8–12% sulphuric acid, maintained at a temperature of about 180 degrees F. by automatic temperature controls actuated from bulb type thermometers. Speed ranges of the lines are 50–140 ft. per minute on the 84″ and one 36″ line, and 50–175 ft. per minute on the 72″ and other 36″ line.

Overall length of the pickling lines is approximately 550 ft., and the entry ends project back into the raw coil storage, so that handling is reduced to a minimum.

There are five other pickling units, of plunger and rocker types, located at various points in the Sheet Mill.

ANNEALING AND NORMALIZING

Box annealing is performed principally in radiant tube type annealing covers. This type of equipment was chosen following a careful analysis of the problem of annealing sheets and coils from a standpoint of quality, production, and cost, and an exhaustive test of the equipment. There are seventy-six radiant tube covers of the following sizes: Ten, 74″ x 176″ x 74″; twelve, 80″ x 210″ x 80″; twenty-five, 76″ x 176″ x 76″;



R. G. EBERT,
Assistant Superintendent, 42" Hot Strip Mill

and twenty-nine, 60" x 210" x 60". This combination of sizes works out well in taking care of the many different sizes of sheets and coils produced.

The covers are fired with stabilized oil refinery gas, some through complete or partial pre-mixing burners, the majority through inspirating burners. About 255 bases are installed, averaging close to 3½ bases per cover. As the cooling cycle requires about twice as much time as the heating cycle, this proportion of bases gives one extra base for each two covers, so as to allow ample time for loading and splitting off. For every base there is a mild steel corrugated inner cover, so that the heating cover can be continuously utilized.

Twenty-two of these covers employ horizontal tube elements for heating, with fifty-four using vertical tubes. The latter are equipped with automatic electric ignition devices for lighting up the furnace, as well as automatic vertical temperature control in addition to the standard temperature control. Exhaust gases from each cover are gathered in headers mounted on the furnace, and are conducted to an underground flue system through down-comers which are self-sealing in a sand seal.

Due to the great variety of products annealed, temperature and annealing cycle requirements vary widely, ranging from 1000 to 1380 degrees F., and from 15 to 80 hours.

Gas cracking units supply a conditioned gas for the necessary atmosphere for deoxidation in the annealing furnaces. There are twelve of these units in the sheet mill, one rated at 1000 cu. ft. per hour, eight at 4000 cu. ft. per hour, and three at 15000 cu. ft. per hour. Gas tight construction of the furnace bases makes good deoxidation a certainty.

Four normalizing furnaces are installed in the sheet mill. An open annealing unit, 108" wide by 85' long, is located in the end of the hot mill building. It has a chain type conveyor with alloy flights, travelling in a speed range of 8⅔–80 ft. per minute. It is fired with gas or oil through air pressure burners, and has a capacity of about 150 tons in 24 hours. There are two normalizing furnaces 80" wide by 160' long, with disc type alloy roller hearths, fired with natural gas or oil through inspirating burners. Material travels through these furnaces at speeds of 6–18 ft. per minute, and each furnace has a capacity of 160 tons in 24 hours. There is also a bright annealing unit, 80" wide by 230' long, heated by electric resistors. Material speeds range 4–38 ft. per minute, and capacity is about 60 tons in 24 hours. This furnace operates with an atmosphere of conditioned gas in order to obtain the required bright finish. The electrical resistors represent a connected load of 2000 K.V.A.

COLD MILLS

The cold reduction department of the sheet mill is composed of one tandem mill, two reversing mills, and five temper mills. The tandem mill consists of three four-high stands, 20.5" and 56" x 84", with roller bearings on the work rolls and oil-flooded bearings on the back-up rolls. The first stand is driven by a 1500 H.P., 600 volt, 200-400 R.P.M., D.C. motor, through a gear reduction of 8.4 ratio. The second and third stands are each driven by a 2500 H.P., 225-450 R.P.M. motor of the same characteristics, with gear ratios of 5.5 and 4.43 respectively. The mill is equipped with a reel, with 30" diameter drum, driven by a 350 H.P., 600

View of four continuous pickling lines. Tanks are of steel plate construction, rubber lined, with an inner lining of vitrified brick laid in a special bonding material.

volt, 200-600 R.P.M., D.C. motor, through gearing of 7.956 ratio. Based on these motor speeds and ratios, mill speeds are as follows:

	Roll Speed, R.P.M.	Strip Speed, Ft. per Min.
No. 1 Stand	23.8– 47.6	128–256
No. 2 Stand	40.9– 81.8	217–435
No. 3 Stand	50.8–101.5	271–542
Reel	25–75	197–590

Power for the tandem mill is furnished by a dual motor-generator set consisting of two 3000 K.W., 600 volt D.C. generators driven by one 8400 H.P., 6600 volt, 60 cycle, 360 R.P.M. synchronous motor. This unit also includes a 125 K.W. tension reel booster generator, a 100 K.W. feed reel booster, and a 125 K.W. exciter, all of 230 volts D.C.

One reversing mill consists of a single 4-high stand, 20.5 and 56″ x 84″, with reel on each side. This mill is driven at roll speeds of 50-100 R.P.M. by a 1500 H.P., 600 volt, D.C., 200-400 R.P.M. motor, and is equipped with roller bearings on both work rolls and back-up rolls. The reels are each driven by a 700 H.P., 600 volt D.C., 150-525 R.P.M. motor. The second reversing mill is 4-high, 20.5 and 56″ x 72″, with roller bearings on the work rolls and oil-flooded bearings on the back-up rolls. The main drive is a 4000 H.P., 150-300 R.P.M. motor, while the reel drives are 1500 H.P., 150-525 R.P.M., all of 600 volts D.C. Strip speed through the 84″ mill ranges 268–536 ft. per minute, and 412–825 ft. per minute through the 72″ mill. Ratios of the reduction gear sets are 4.025 and 1.95 respectively.

J. L. PEET,
Superintendent Maintenance Departments, Sheet and Tin Mills

The 84″ reversing mill draws power from a 1750 K.W., 600 volt generator, with 240 K.W. booster generator and 50 K.W. exciter, driven by a 2800 H.P., 2200 volt, 500 R.P.M., 25 cycle synchronous motor. Power for the 72″ mill is furnished by a 3000 K.W., 600 volt D.C. generator, with 800 K.W. booster generator and 100 K.W. exciter, driven by a 5500 H.P., 6600 volt, 360 R.P.M., 60 cycle synchronous motor.

These mills produce cold rolled material from 27″ to 80″ in width, in gauges of .015″ to .061″. The reduction effected by cold rolling in the sheet mill may run 40–65%.

There are also two 60″ and three 84″ temper mills, for which power is furnished by a 500 K.W., 250 volt D.C. generator, with a 125 K.W., 125 volt D.C. backing generator and a 25 K.W., 250 volt, exciter, all driven by a 760 H.P., 6600 volt motor.

Auxiliary D.C. power in the cold reduction department is supplied by two 1000 K.W., 250 volt D.C. motor-generator sets.

Cold mills are equipped with automatic gaugers, and with roll pressure indicating devices.

Additional finishing equipment includes:

One cutting line for cutting flat sheets 36″–76″ wide, ¼″ thick, up to 15 ft. long; includes tables, roller leveller, trimmer, shear and gauge.

One cutting line for cutting flat sheets 36″–76″ wide, ¼″ thick, up to 30 ft. long; includes tables, trimmer, shear, and leveller.

Box annealing is performed principally in radiant tube type annealing covers. There are approximately seventy-six radiant tube covers for annealing sheets and coils.

One shear for automatic squaring of flat sheets, 26″–76″ wide, ¼″ thick, up to 176″ long; includes two side shears, two end shears, conveyors, and leveller.

Two flying shear lines for cutting flat sheets from coils 36″–76″ wide by 176″ long, No. 10 gauge; includes uncoiler, trimmer, flying shear and leveller.

One trimming and recoil line for No. 10 gauge material, 26″–76″ wide; includes uncoiler, trimmer and recoiler.

Five 156″ resquaring shears; One 144″ resquaring shears; Five 84″ resquaring shears.

Two oiling machines.

One roller leveller, 89″ x 3¾″, for stock 76″ wide, No. 16–28 gauge.

Two roller leveller, 88″ x 7″, for stock 80″ wide, ¼″ thick.

Three roller levellers, 84¼″ x 5¼″, for stock 80″ wide, ¼″ thick.

One roller leveller, 108″ x 5½″, for stock 96″ wide, ¼″ thick.

Two roller levellers, 86″ x 5½″, for stock 80″ wide, ¼″ thick.

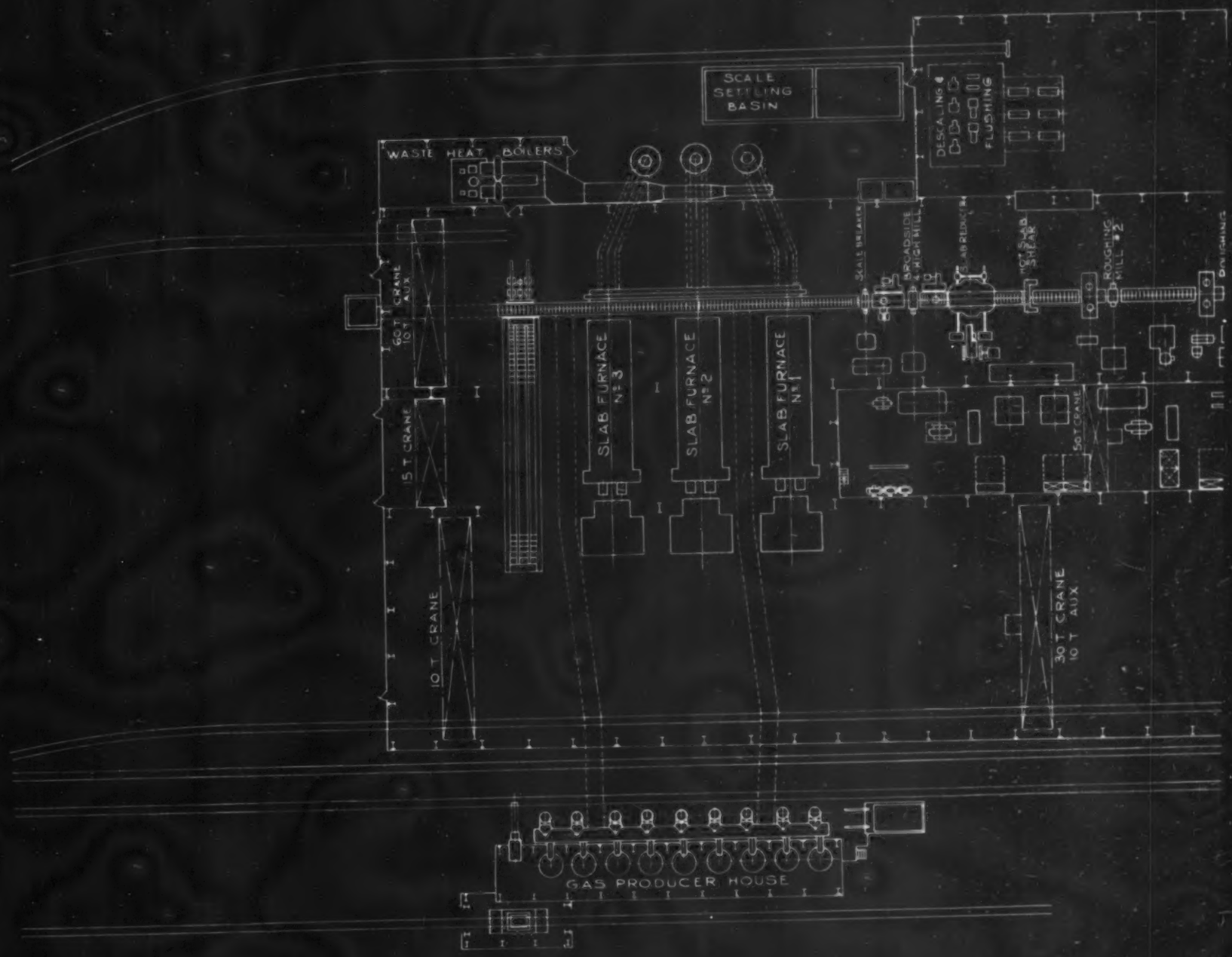
One roller leveller, 48″ x 2¾″, for stock 42″ wide, No. 14 gauge.

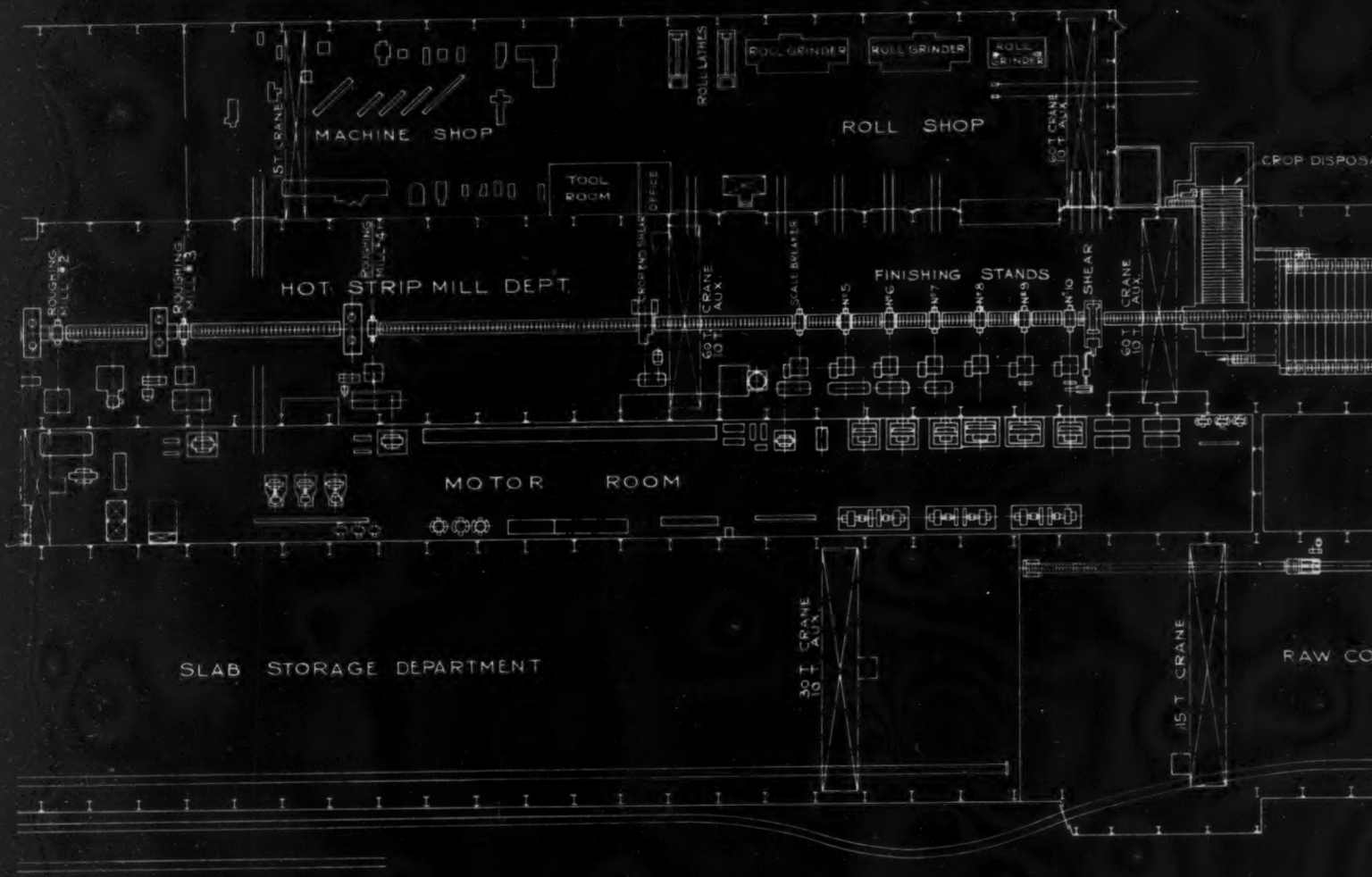
CONVENTIONAL SHEET MILLS

The sheet mill plant also includes several trains of conventional sheet hot mills, with individual pack furnaces, in which breakdowns from the strip mill may be further reduced. This unit of the plant also includes cold rolls, box annealing and pickling facilities, all of

MILL DATA

Mill	Characteristics	Work Roll Diam.	Backup Roll Diam.	Roll Length	MOTOR			Type	Remarks
					H.P.	Volts	R.P.M.		
80″ Hot Mill									
No. 1 Scalebreaker	2-high, 1-stand	32″	.....	80″	1250	6600	514	Wound rotor ind.	Geared. Flywheel.
Broadside	4-high, 1-stand	40″	54″	130″	3500	6600	356	Wound rotor ind.	Geared. Flywheel.
No. 1 Edger	1-stand	32″	.....	.....	350	230	400/800	D. C.	Geared.
No. 2 Rougher	2-high, 1-stand	42″	.....	80″	3500	6600	509	Wound rotor ind.	Geared. Flywheel.
No. 2 Edger	1-stand	32″	.....	.....	350	230	400/800	D. C.	Geared.
No. 3 Rougher	4-high, 1-stand	26″	53″	80″	3500	6600	509	Wound rotor ind.	Geared. Flywheel.
No. 3 Edger	1-stand	24″	.....	.....	350	230	400/800	D. C.	Geared.
No. 4 Rougher	4-high, 1-stand	26″	53″	80″	3500	6600	509	Wound rotor ind.	Geared. Flywheel.
No. 2 Scalebreaker	2-high, 1-stand	36″	.....	80″	800	600	150/450	D. C.	Geared.
No. 5 Finisher	4-high, 1-stand	26″	53″	80″	4500	600	125/282	D. C.	Geared.
No. 6 Finisher	4-high, 1-stand	26″	53″	80″	4500	600	125/282	D. C.	Geared.
No. 7 Finisher	4-high, 1-stand	26″	53″	80″	4500	600	125/282	D. C.	Geared.
No. 8 Finisher	4-high, 1-stand	26″	53″	80″	4500	600	85/190	D. C.	Direct drive.
No. 9 Finisher	4-high, 1-stand	26″	53″	80″	4500	600	100/230	D. C.	Direct drive.
No. 10 Finisher	4-high, 1-stand	26″	53″	80″	3000	600	110/255	D. C.	Direct drive.
Sheet Cold Reduction									
Tandem Mill	4-high, 3-stands	20.5″	56″	84″	(1)–1500 (2)–2500	600	200/400 225/450	D. C.	Geared.
Reel	30″ diam. drum	.....	.....	.....	350	600	200/600	D. C.	Geared.
Reversing Mill	4-high, 1-stand	20.5″	56″	84″	1500	600	200/400	D. C.	Geared.
Reels (2)	30″ diam. drums	.....	.....	.....	(2)–700	600	150/525	D. C.	Geared.
Reversing Mill	4-high, 1-stand	20.5″	56″	72″	4000	600	150/300	D. C.	Geared.
Reels (2)	30″ diam. drums	.....	.....	.....	(2)–1500	600	150/525	D. C.	Geared.
Tinplate Cold Reduction									
Reversing Mill	4-high, 1-stand	16.5″	49″	42″	(2)–600	600	500/800	D. C.	Geared.
Reels (2)	.....	.....	.....	.....	(2)–500	600	300/900	D. C.	Geared.
Reversing Mill	4-high, 1-stand	16.5″	49″	42″	(2)–600	600	500/800	D. C.	Geared.
Reels (2)	.....	.....	.....	.....	(2)–500	600	300/900	D. C.	Geared.
Tandem Mill	4-high, 5-stand	20.5″	49″	42″	(1)–500 (4)–1250	600	(1)400/600 (4)300/600	D. C.	Geared.
Reel	.....	20″	.....	42″	150/250	600	250/1000	D. C.	Geared.
Tandem Mill	4-high, 5-stand	20.5″	49″	42″	(1)–500 (4)–1250	600	(1)400/800 (4)300/600	D. C.	Geared.
Reel	.....	20″	.....	42″	150/250	600	250/1000	D. C.	Geared.


SCALE SETTLING BASIN
WASTE HEAT BOILERS
DESCALING & FLUSHING
SCALE BREAKER
BROADSIDE 4 HIGH MILL
S. AD REDUCTION
HOT SLAB SHEAR
ROUGHING MILL No 2
DRIVING
60 T CRANE 10 T AUX
SLAB FURNACE No 3
SLAB FURNACE No 2
SLAB FURNACE No 1
50 T CRANE
15 T CRANE
10 T CRANE
30 T CRANE 10 T AUX
GAS PRODUCER HOUSE



PLAN VIEW OF 80 IN. HO
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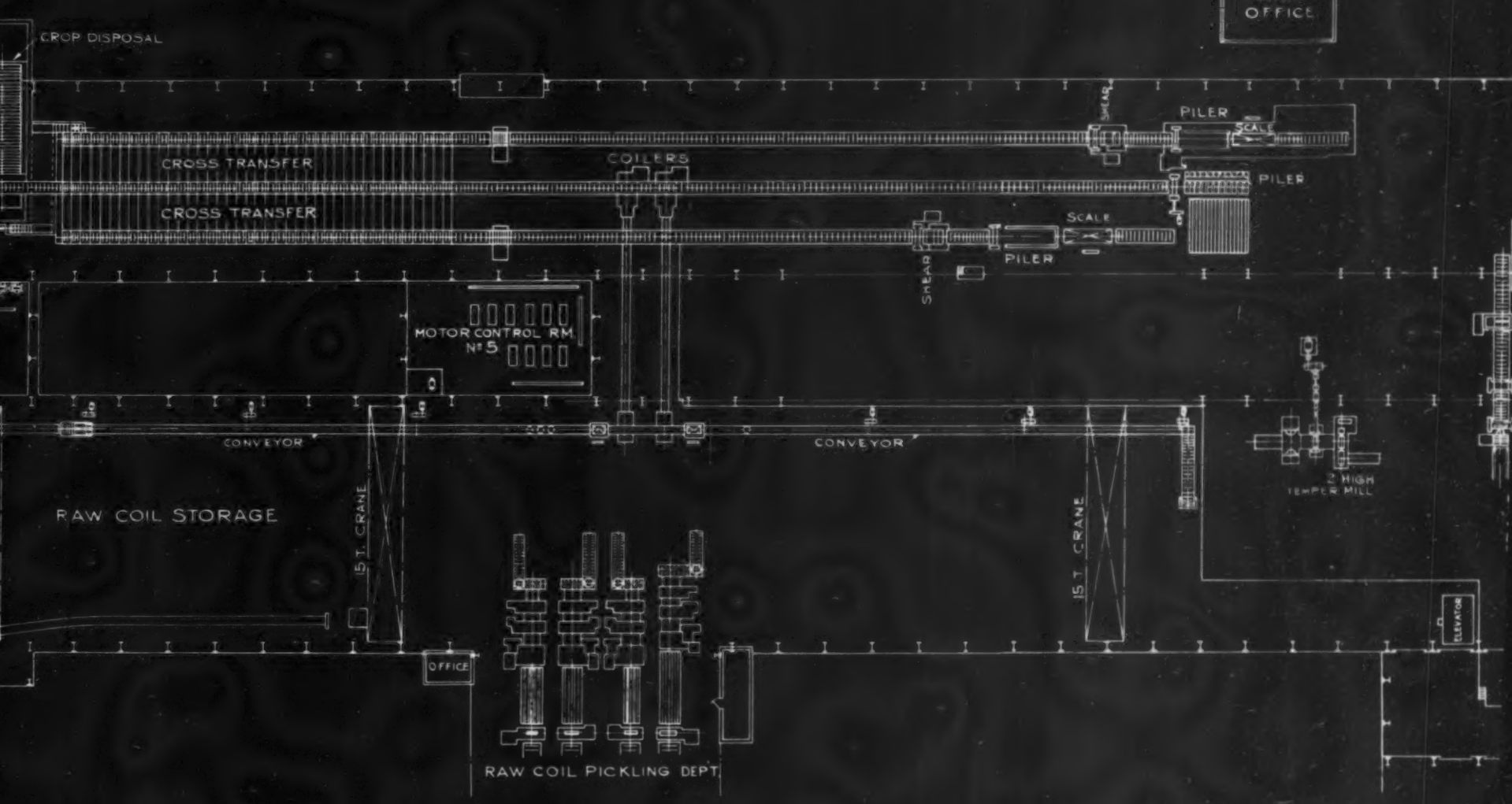
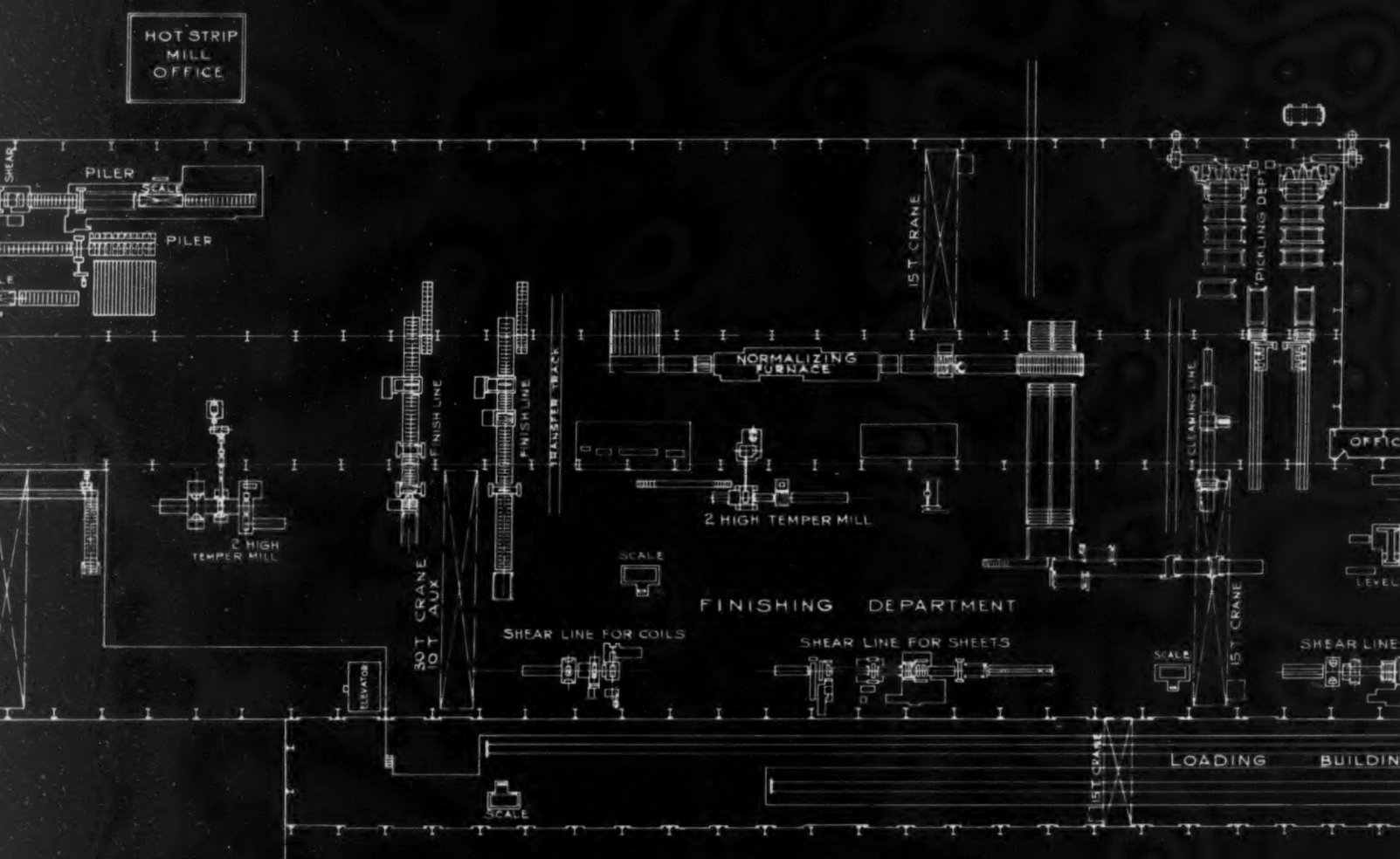
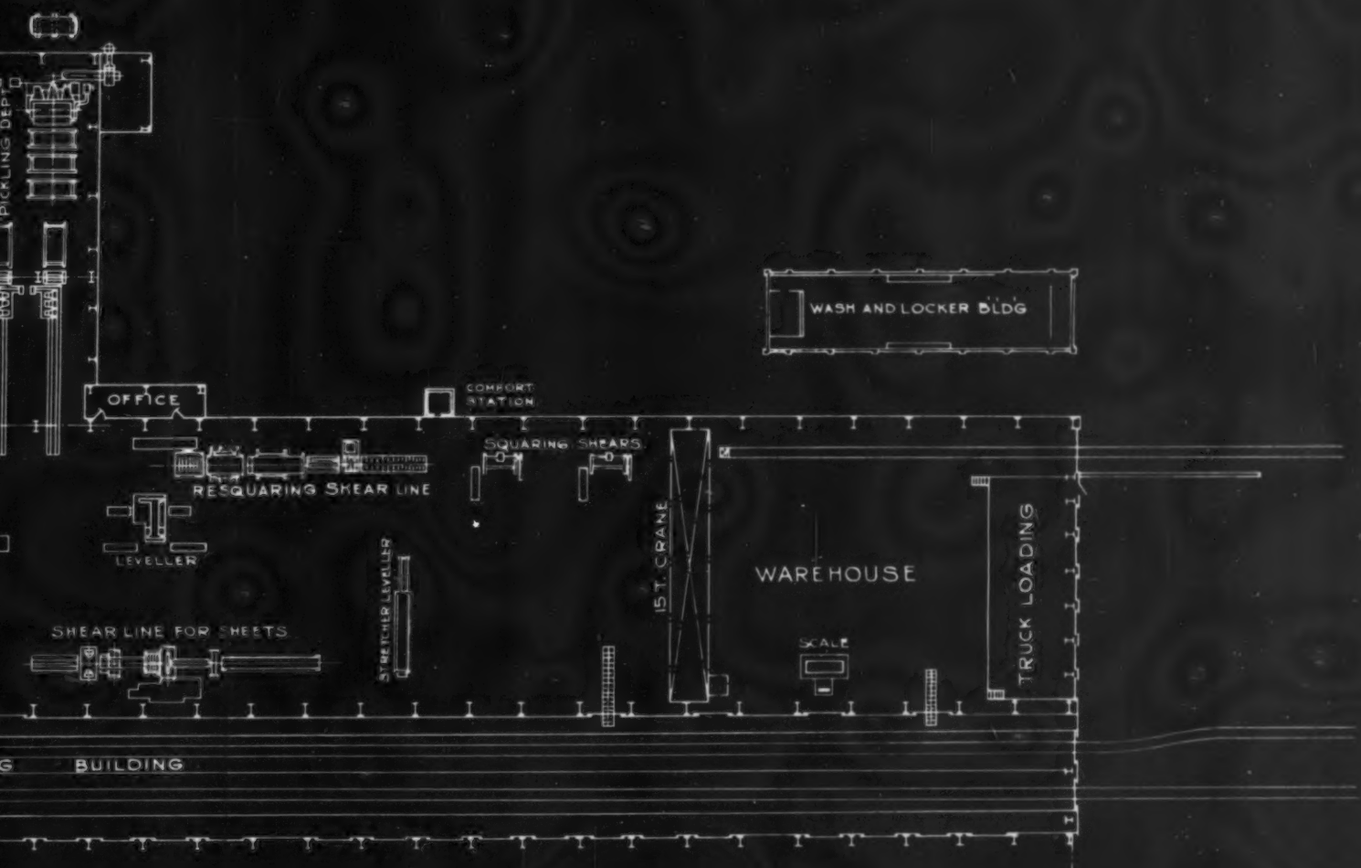


HOT STRIP MILL, CARNEGIE-ILLINOIS STEEL CC
SHEET AND TIN MILLS - GARY IND.



IS STEEL CORPORATION

D.


PICKLING DEPT.
WASH AND LOCKER BLDG
OFFICE
COMFORT STATION
SQUARING SHEARS
RESQUARING SHEAR LINE
LEVELLER
SHEAR LINE FOR SHEETS
STRETCHER LEVELLER
15T. CRANE
WAREHOUSE
SCALE
TRUCK LOADING
BUILDING

the older conventional type, as well as a sheet galvanizing and corrugating department.

TIN MILLS

The tin mill plant consists primarily of a 42″ hot strip mill, some conventional type hot mills and cold mills, facilities for white pickling and annealing, black pickling and annealing, tinning and assorting. In line with the general modernization, recent additions have been made in the way of cold reducing mills, electrolytic cleaning lines, a continuous pickler, and modern box annealing equipment. It is to these newer installations that space necessarily limits our discussion.

The continuous pickling line is of a nominal width of 36″, and is essentially a duplicate of the 36″ lines located in the sheet mills, and previously described in this article.

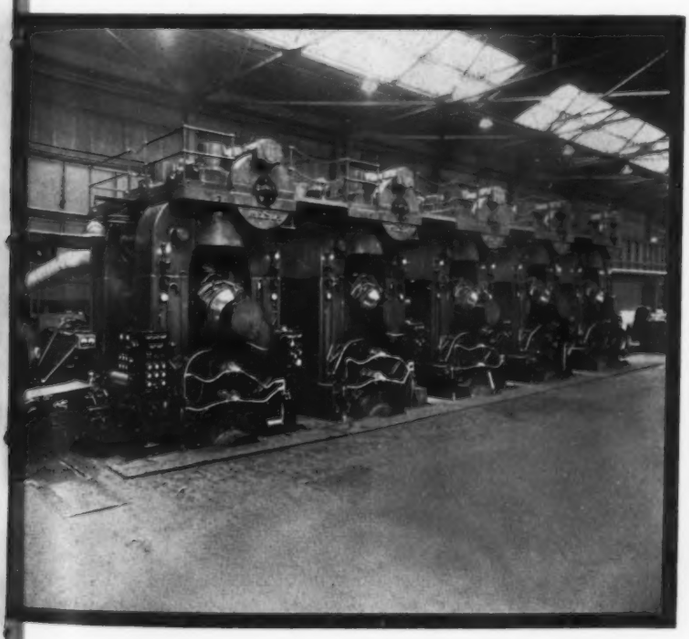
There are two single stand reversing cold mills, each 4-high, 16.5 and 49″ x 42″, with roller bearings on both work rolls and back-up rolls. Each mill is driven by two 600 H.P., 600 volt D.C., 500-800 R.P.M. motors, through gear reductions of 4.19 ratio. Reels precede and follow each mill, each driven by a 500 H.P., 600 volt D.C., 300-900 R.P.M. motor. Strip speed through the mills ranges 414–825 ft. per minute.

The reversing mills are operated from two motor-generator sets: One 1250 K.W., 600 volt D.C. generator, with 150 K.W., 300 volt exciter, driven by an 1800 K.V.A., 2300 volt, 750 R.P.M., 25 cycle synchronous motor.

One 1750 K.W., 600 volt D.C. generator with 300 K.W., 300 volt exciter, driven by a 2800 H.P., 2300 volt, 500 R.P.M., 25 cycle synchronous motor.

These mills, installed in 1933, were the first single stand reversible cold reduction strip mills in the country.

One of two duplicate five stand tandem cold reduced tin mills. Roller bearings are used on the work rolls, and oil flooded bearings on the back-up rolls.



O. V. GRAY, (*left*)
Assistant to General Superintendent, Sheet and Tin Mills

R. P. DEPUTY, (*right*)
Superintendent, Finishing Departments, Sheet Mills

W. F. WOODS,
Superintendent, Hot Tin Mills

C. E. MILLER,
Superintendent, Finishing Departments, Tin Mill

T. R. OWENS,
Superintendent, Hot Sheet Mills

Two duplicate five stand tandem mills have also been installed. These stands are 4-high, 20.5″ and 49″ x 42″, spaced on 13 ft. centers. Roller bearings are used on the work rolls, and oil-flooded bearings on the back-up rolls. The first stand is driven by a 500 H.P., 600 volt ,D.C., 400-800 R.P.M. motor, while the other four stands employ 1250 H.P., 300-600 R.P.M. motors. A reel follows each train, equipped with a 150-250 H.P., 250-1000 R.P.M. motor. Gear ratios and mill speeds in these mills are as follows:

	Gear Ratio	Roll Speed R.P.M.	Strip Speed, Ft. per Min.
No. 1 Stand	14.8	27– 54	145– 290
No. 2 Stand	6.25	48– 96	257– 515
No. 3 Stand	3.9	77–154	414– 828
No. 4 Stand	2.92	102–204	550–1100
No. 5 Stand	2.63	114–228	610–1220
Reel	4	62.5–250	.....

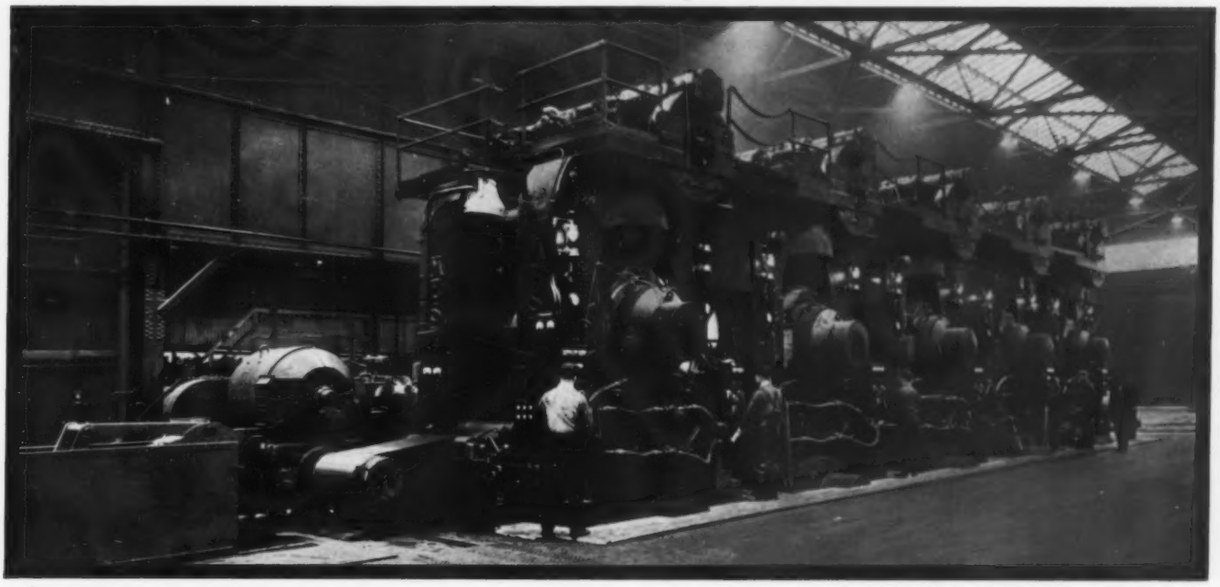
The two tandem mills receive power from two motor-generator sets, each a dual unit consisting of two 2500 K.W., 600 volt D.C. generators, with 75 K.W. booster generator and 100 K.W. exciter, driven by a 5400 K.V.A., 6600 volt, 514 R.P.M., 60 cycle synchronous motor.

Mechanical type strip tension indicators are used on the tandem trains, as are roll pressure indicating devices.

Product from the tin cold reduction department ranges 18″–37″ in width, in gauges of .032″–.008″.

The electrolytic cleaning lines process the cold rolled strip at speeds over 900 ft. per minute. These lines start with an uncoiler which receives the tightly wound coils from the cold mills. Ends of succeeding coils are joined by a seam type electric welder. The strip then proceeds through a power washer, where the greater part of the oil is removed by high pressure sprays of hot cleaning solution. Following this there is a scrubber in which brushes rotate in a direction opposite to the movement of the strip. Next the strip passes through an electrolyzed tank in which the material is the cathode, while the anodes are spaced above and below the strip. Next is another scrubber, followed by a hot rinse tank and drying equipment. The strip is pulled through the line against controlled back tension by a set of pinch rolls ahead of the dryer. These rolls, as well as the rewinding reel, are operated by a motor-generator set with Ward-Leonard control.

Box annealing equipment in the tin mills, for cold reduced products is entirely of the radiant tube type covers. There are forty covers, 76″ x 170″ x 76″, all of the same type as the greater part of those in the sheet mill. They are fired with stablilized oil refinery gas through inspirating burners into vertical tubes. The forty covers are used in conjunction with 120 bases, averaging 3 bases per cover. A corrugated inner cover is provided for each base. Bases are arranged in two long rows, between which a track runs the entire length of the building. Tinplate coils are



Number 3-five stand tandem cold reduction tin mill. Mechanical type strip tension indicator is used on this mill as well as the other five stand tin mill.

Three stand tandem cold reduction sheet mill. This mill is equipped with automatic gaugers, and with roll pressure indicating devices.

distributed from cars running on this track to any desired point in the annealing department. This arrangement greatly facilitates the handling problem, and eliminates a great amount of crane travel.

A normal charge for these furnaces consists of sixteen coils, piled in two rows, two coils high, making a total charge of 40 tons when 5000 lb. coils are used. Time of annealing varies from 18 to 50 hours, in a temperature range of 1150-1350 degrees F., depending on the product.

There are nine gas conditioning machines in this department, each of 400 cu. ft. per hour capacity. Deoxidation is handled in the same manner as in the sheet mill, the gas being piped to each base from the conditioning units. Steam is also available at each base for steam bluing.

Temper mill equipment in the tin mills includes five 42″ single stands and one two-stand train.

SUMMARY OF CONNECTED LOAD

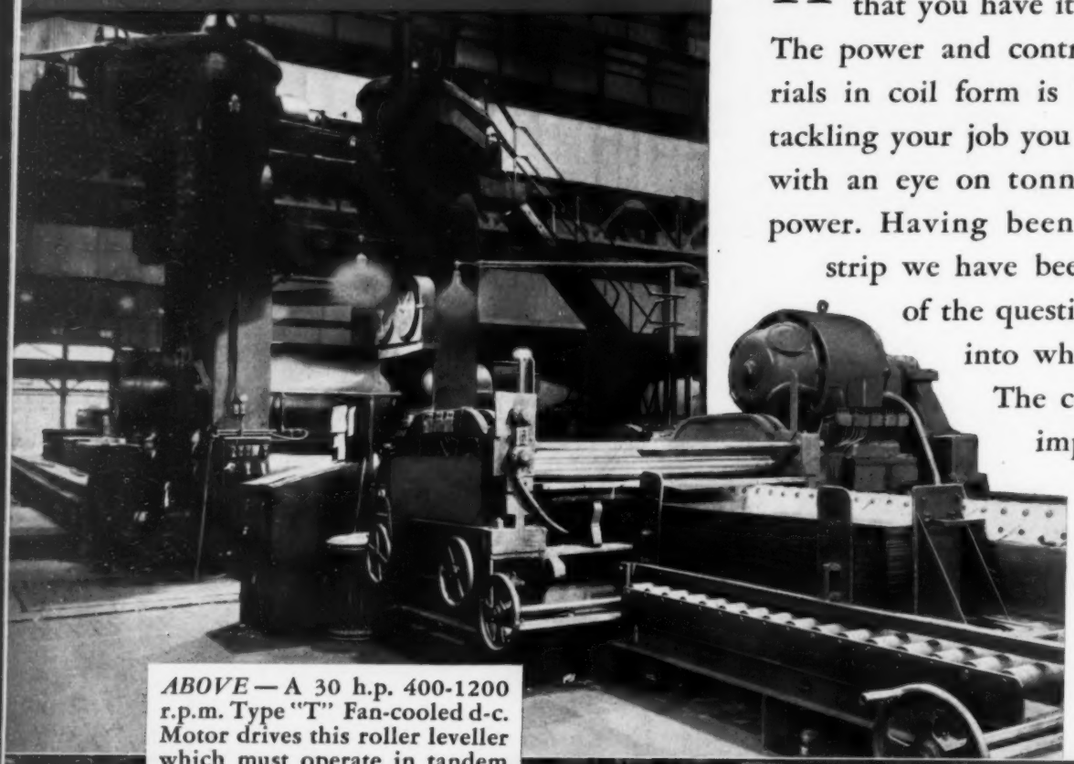
(80- Hot and Cold Strip Mills and Finishing)

	K.V.A.
No. 1 Scalebreaker	
1250 H.P. x .746, 90% P.F.	1035
No. 1 Broadside	
3500 H.P. x .746, 90% P.F.	2900
No. 2, 3, and 4 Roughers	
3 x 3500 H.P. x .746, 90% P.F.	8700
Finishing Mill M.G. Sets	21500
Spray Pumps, 80″ Mill	2980
Auxiliary, M.G. Sets	6610
Cold Mill M.G. Sets	16350
Auxiliary Power and Light Transformers	11025
Power Transformers, 6600/2200 Volts	7500
Electric Annealing Furnace	2000
Total 6600 Volt Load	80600

COINCIDENTAL DRIVES FO

RELIANCE

HOW are you going to process that coil now that you have it? Maybe we can be of help. The power and control end of processing materials in coil form is "right down our alley." In tackling your job you can be sure of our working with an eye on tonnage and quality — not just power. Having been in on the production of strip we have been thinking ahead on some of the questions you are going to bump into when you come to processing. The coincidental drive will be an important factor and we have ideas on how to put it to work. Some samples are shown here. If these interest you, any Reliance man can tell you more about them . . . Ask him.



ABOVE — A 30 h.p. 400-1200 r.p.m. Type "T" Fan-cooled d-c. Motor drives this roller leveller which must operate in tandem with the temper pass mill.

A 76-inch Continuous Trimming and Shearing Line. Shear and side trimmer are each driven by 400-1600 r.p.m. adjustable-speed d-c. motors, operating in tandem. A typical speed range for travel of strip is 100-400 feet a minute . . . The uncoiler cone adjustment is operated by a 5 h.p. gearmotor with an a-c. high-torque motor unit.

ABOVE — T
Heavy-duty R
pole D-c. M
anti-friction
Solid cover
openings, scre
over lower po

RIGHT
Enclosed
Reliance
Motor.

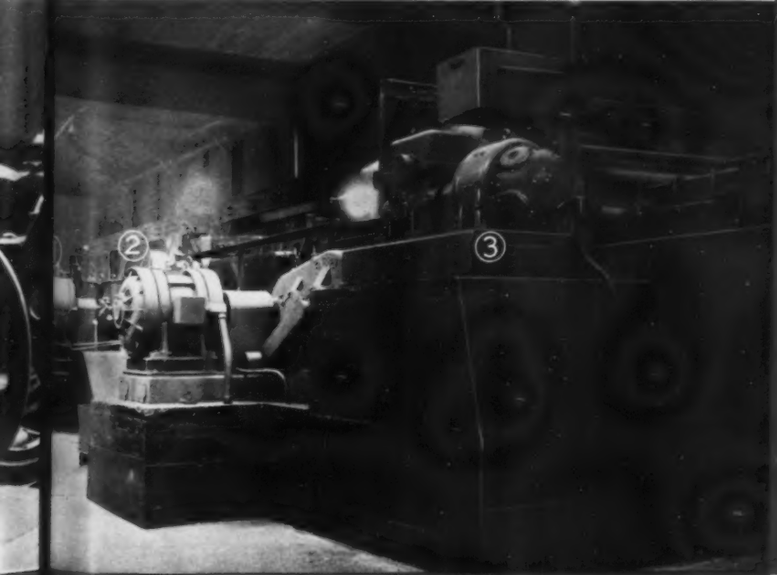
RELIANCE A-C D-C MOTORS

ES FOR PROCESSING *Strip*

ABOVE — Type "T" Heavy-duty Reliance 6-pole D-c. Motor with anti-friction bearings. Solid cover over top openings, screen covers over lower portion.

RIGHT — Type "AA" Enclosed, Fan-cooled Reliance Squirrel-cage Motor.

These vertical a-c. motors are examples of building to meet specific needs of steel processing. They drive circulating fans in strip-steel annealing furnaces. Special design features have been incorporated for keeping the shafts and bearings cool.



LEFT — Delivery end of 80-inch Continuous Strip Pickling Line. Eleven motors supply the power for main drives throughout the line. Six d-c. adjustable-speed motors operating in tandem are employed when required to suit the rate of pickling which varies over a 1 to 4 range. For the more rapid operations such as shearing and stitching, a-c. squirrel-cage motors with special torque characteristics are used . . . The illustration shows master pinch roll *(1)* with 40 h.p. d-c. fan-cooled motor; up-cut shear *(2)* with 50 h.p. enclosed a-c. motor; shear pinch-roll *(3)* with 10 h.p. d-c. fan-cooled motor.

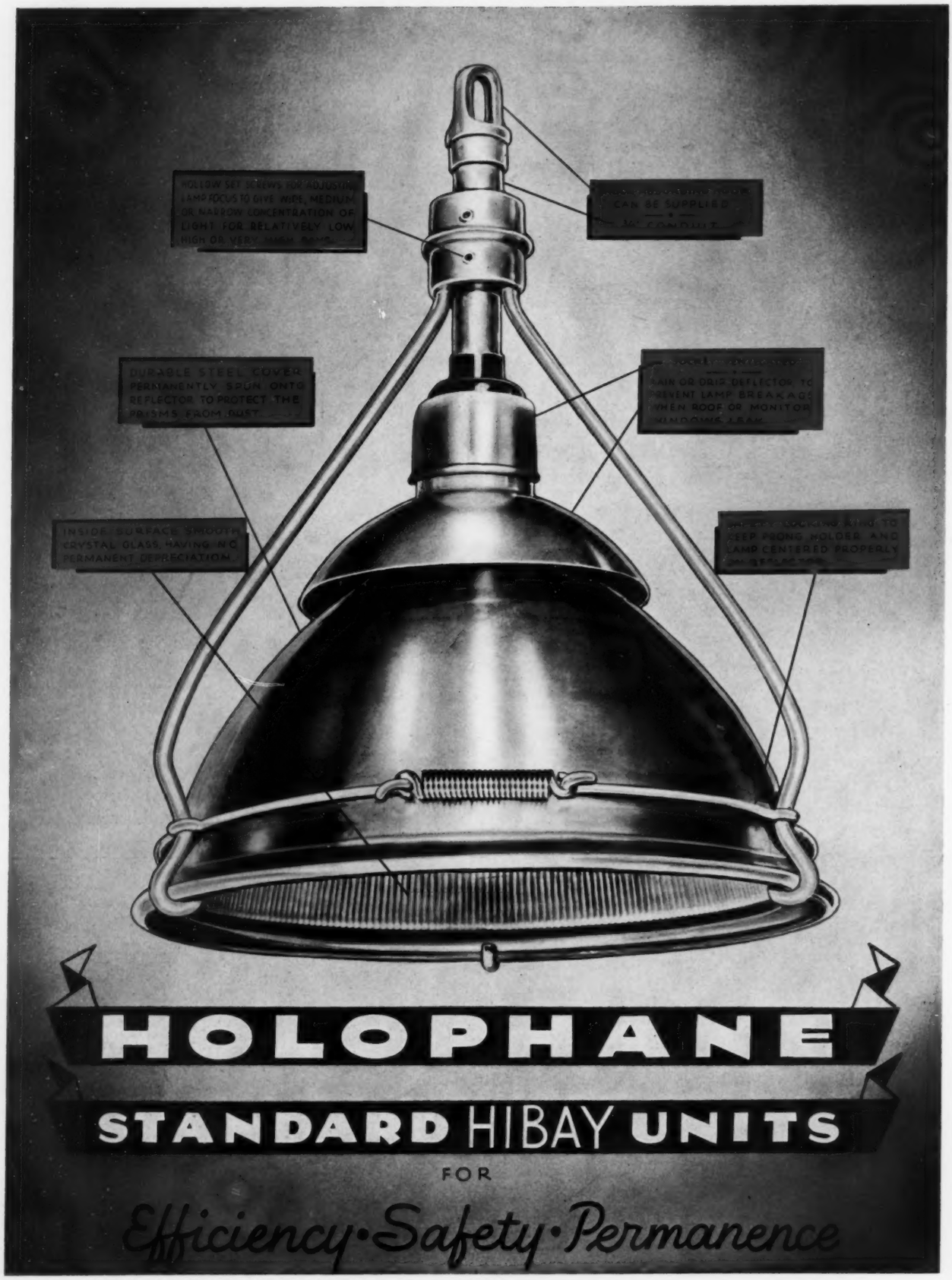
RELIANCE ELECTRIC & ENGINEERING COMPANY

1088 IVANHOE ROAD

CLEVELAND, OHIO

Branches: Birmingham, Boston, Buffalo, Chicago, Cincinnati, Detroit, Greenville *(S. C.)*, New York, Philadelphia, Pittsburgh.

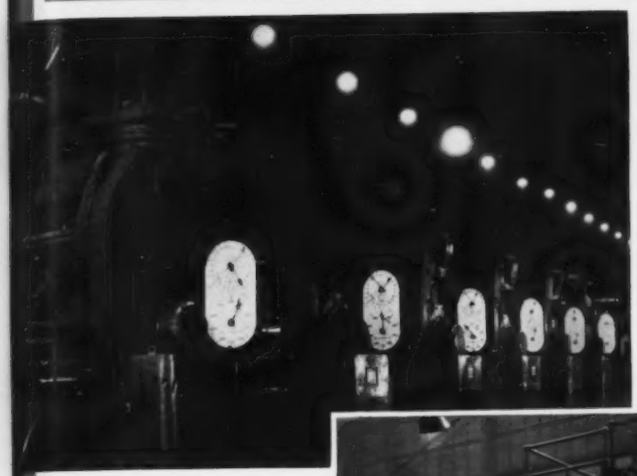
Representatives in other Principal Cities.



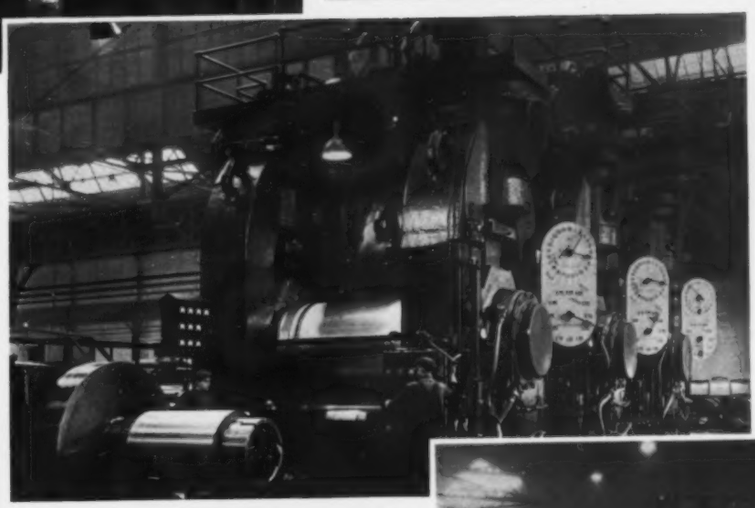
Holophane HIBAY Units have been installed in the foremost sheet and tin plants in the country. Write for Engineering data

● HOLOPHANE COMPANY, Inc.
342 MADISON AVENUE, NEW YORK CITY

CONTINENTAL



These mills designed and built by CONTINENTAL for Chicago district



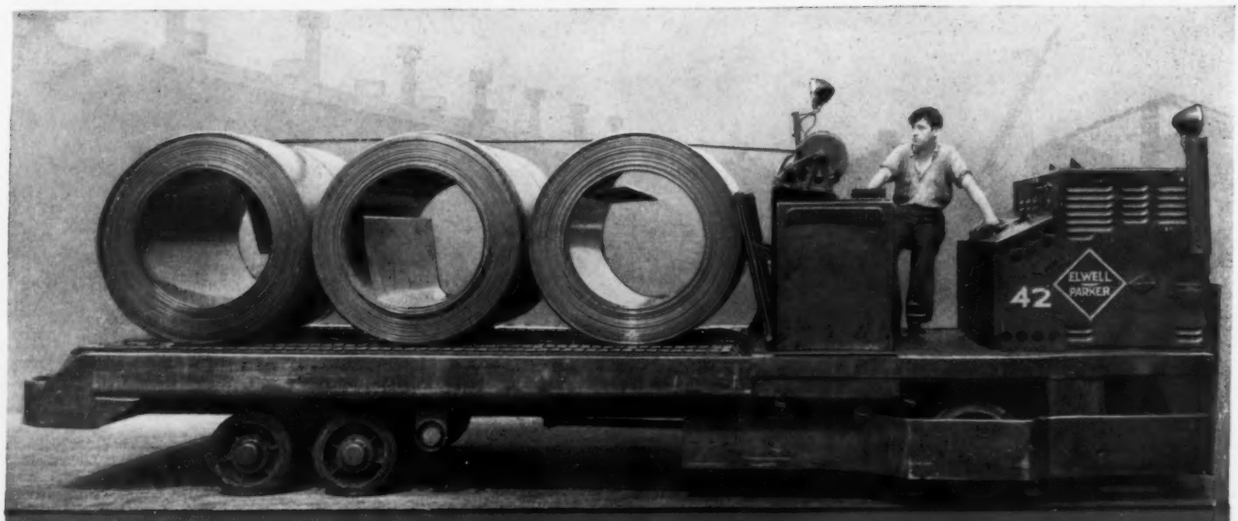
80" Continuous Hot Strip Mill

84" Continuous Cold Strip Mill

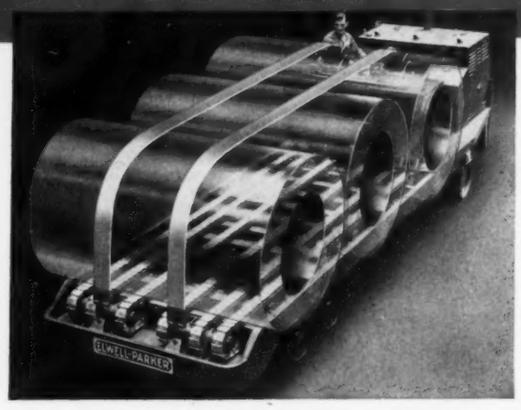
38" Continuous Hot Strip Mill

CONTINENTAL ROLL & STEEL FOUNDRY CO.

CHICAGO, ILL. PITTSBURGH, PA.



THE FIRST CHAIN TRUCK TO HANDLE 76″ COILS OF STRIP WAS AN ELWELL-PARKER P-6



● Even the most unique method of steel transportation soon is quickly forgotten for itself—though appreciated through the years because of its excellent daily performance.

The small view shows the first Chain Truck, P-6, to go into active service. The large picture shows it at work, about a year after it had been installed. This Truck was one of two designed by Engineers of the Steel Company and of Elwell-Parker, who built them, *and the first of its kind to be put into service.*

Elwell-Parker supplied these pioneering Model P-6 Chain Trucks because of unusual loads, handled under unusual conditions. Longer hauls, for example; speedy rate of travel; exceptionally large coils (up to 60″ diameter, and totaling 20 tons); quick yet careful loading and unloading by means of chains, the speeds of which were timed to avoid damage to the coils transported.

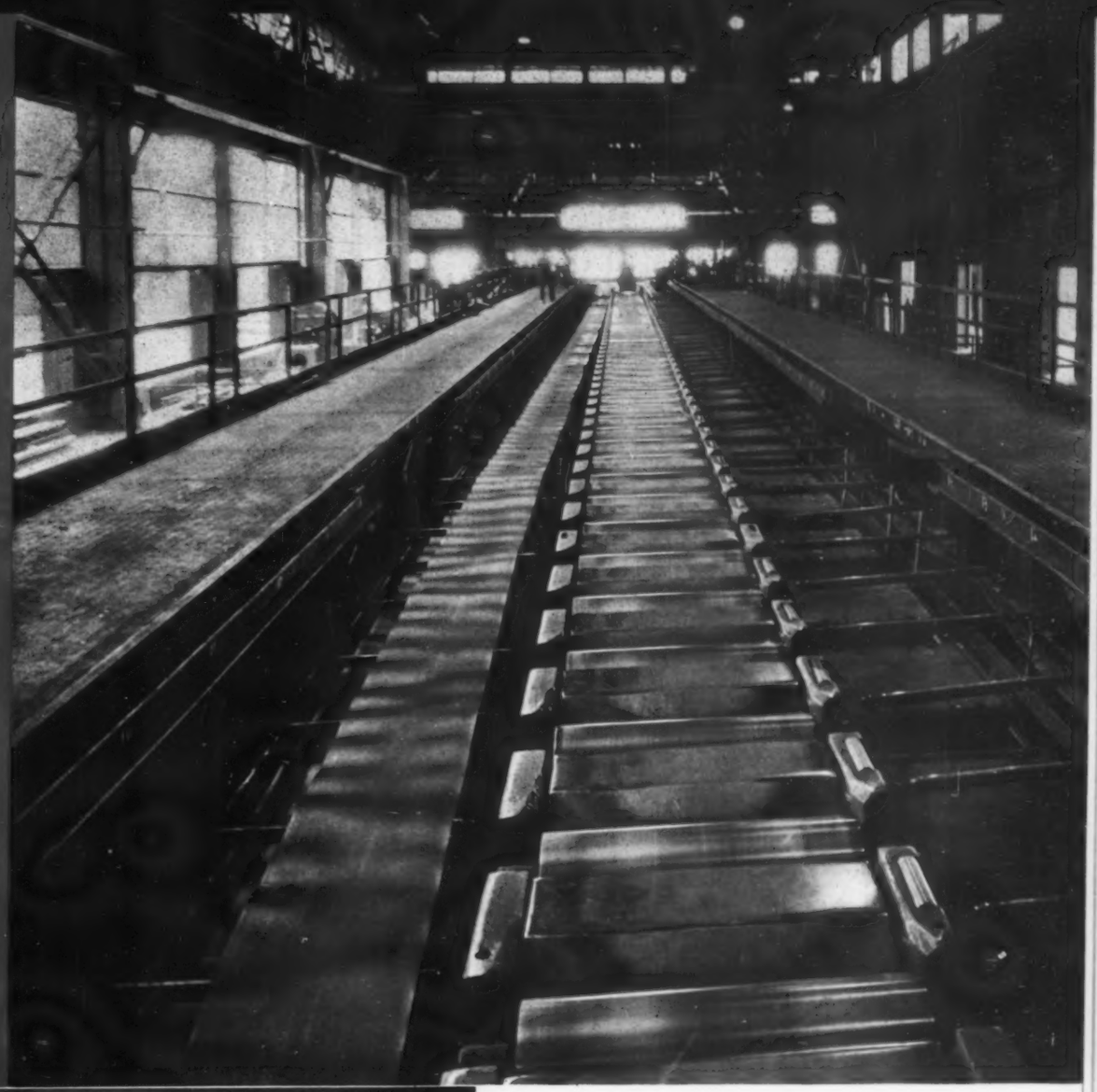
Today, with transportation taking on new importance as a factor in lower-cost production of steel, Transportation Engineers find Elwell-Parker's co-operation of major importance in designing Truck Equipment for special, as well as all standard, transportation jobs.

Elwell-Parker has built for Steel for a generation. Its advance planning, backed by such practical experience, will bring a quick solution of your own problems when you call in an Elwell-Parker Steel Engineer. The Elwell-Parker Electric Co., 4504 St. Clair Ave., Cleveland, O.

New Type **ELWELL·PARKER** *Trucks*

ESTABLISHED 1893 • BUILDING POWER INDUSTRIAL TRUCKS SINCE 1906

Operating for Years without delay to the Mill



SCHLOEMANN "MOTOR-ROLLERS"

are liberally provided with that extra-dependability to withstand abuse of severe steel mill service.

Their simple, rugged construction offers better performance, longer life and avoids costly delays.

Above: "Motor-Roller" Runout Table.
Left: "Motor-Rollers" Between Mill Stands.

SCHLOEMANN

ENGINEERING CO. PITTSBURGH, PA.
Rolling Mill Machinery Hydraulic Presses

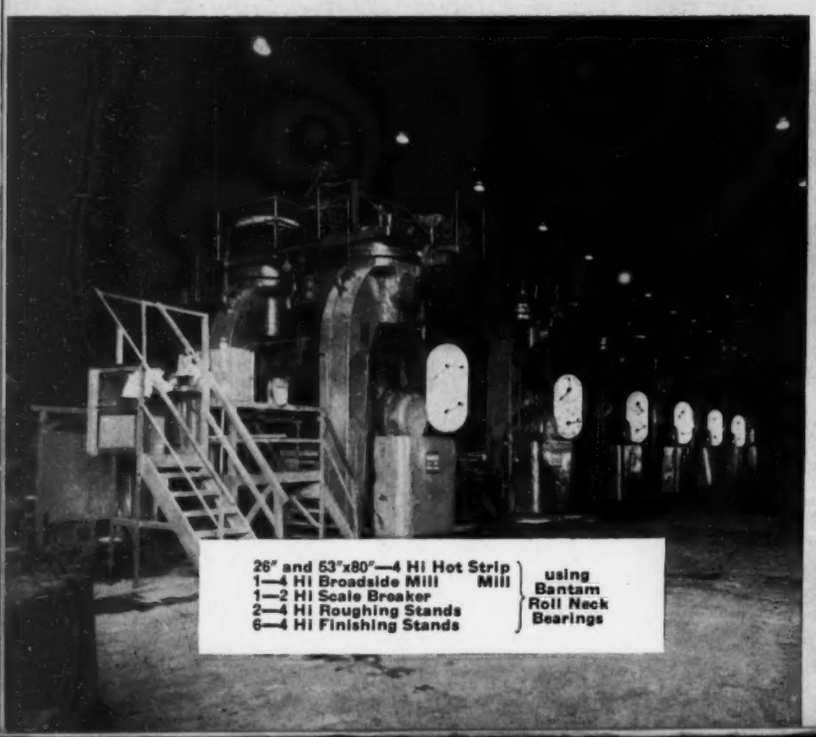
THIS MILL COULD AFFORD

Note how Bantam

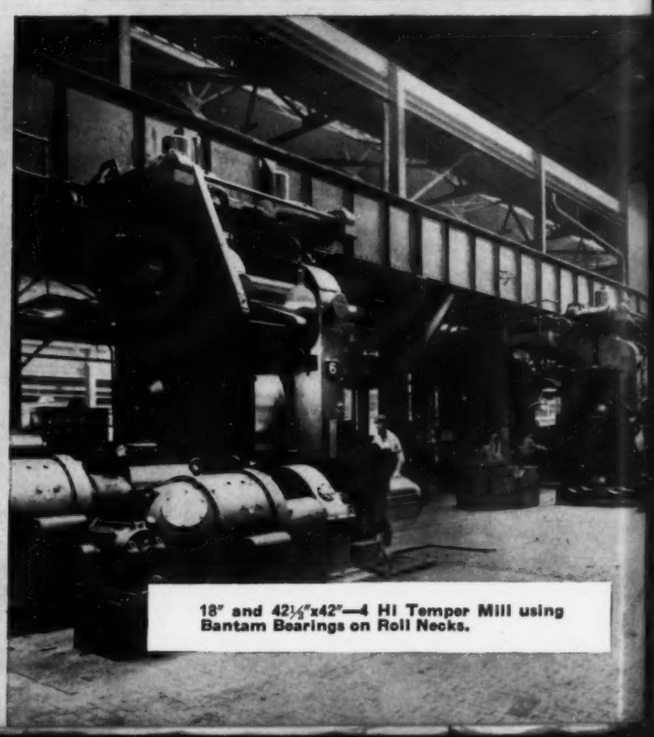
20" and 48"x60" Temper Mills using Bantam Bearings on Roll Necks.

20" and 48"x84"—4 Hi Cold Mill using Bantam Roll Neck Bearings.

★ NO PHOTOGRAPH SHOWN OF 100% BANTAM INSTALLATION ON 18" AND 43" x 38" HOT STRIP MILL.



26" and 53"x80"—4 Hi Hot Strip Mill
1—4 Hi Broadside Mill
1—2 Hi Scale Breaker
2—4 Hi Roughing Stands
6—4 Hi Finishing Stands
} using Bantam Roll Neck Bearings



18" and 42½"x42"—4 Hi Temper Mill using Bantam Bearings on Roll Necks.

Baker DOES IT AGAIN!

A new super-duty, center-control ram truck especially designed to meet the handling requirements of the new wide continuous strip mills. See it at our booths 75 and 76, Iron and Steel Exposition, Chicago. BAKER INDUSTRIAL TRUCK DIVISION *of the Baker-Raulang Company*. 2166 West 25th St., Cleveland, Ohio.

OLDEST MANUFACTURER OF ELECTRIC VEHICLES

Baker

OWER INDUSTRIAL TRUCKS FOR EVERY PURPOSE

HUNT
(Quick-As-Wink)
CONTROL VALVES
FOR AIR AND HYDRAULIC USE

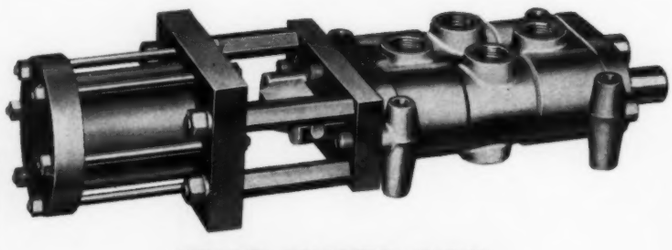
NEW!

Q. A. W. HYDRAULIC CONTROL VALVES

2-WAY • 3-WAY • 4-WAY

½" - ¾" - 1" - 1¼" - 1½" - 2"

FOR HAND LEVER OR PILOT CYLINDER OPERATION



TWO TYPES FOR

1000 POUNDS WORKING PRESSURE

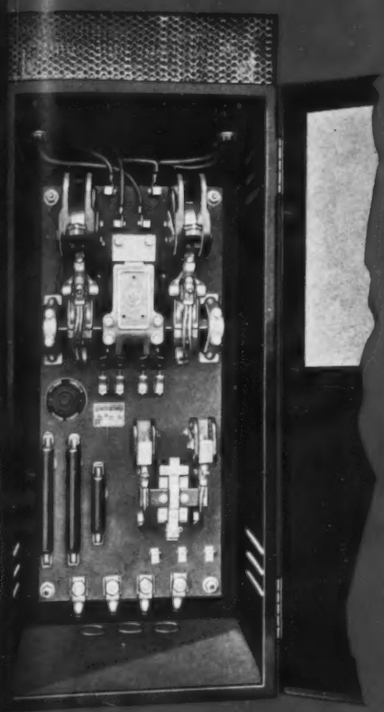
2000 POUNDS WORKING PRESSURE

For water and corrosive fluids in 1" and smaller sizes these valves have heavy bronze forged housing. Also available in 1" and smaller with housings machined from solid steel slab. All types above 1" supplied in housings made from solid steel slab. Bronze housing recommended where possible for water, steel slab valves of the smaller sizes for oil or soluble oil solutions. Stainless steel valve bodies or plungers, balanced action, short travel, no metal-to-metal contact in valving action. Inspection or re-assembly in a few minutes without disturbing hydraulic piping. Pipe connections above or below. Write for complete new catalog of Air and Hydraulic Valves. (I. S.)

C.B. HUNT & SON – SALEM, OHIO

New! AUTOMATIC CONTROLLER

speeds-up lifting magnet operation



for use with single magnets, or 2 or more magnets in parallel

The EC&M Magnet Controller, as illustrated, can be used without change with single magnets from 39 to 65 inches in diameter and with various combinations of magnets operated in parallel. It is only necessary to adjust the rheostat when changing from one size magnet to another to get the desired operation. Similar controllers are built for (1) operation with smaller magnets, (2) for operation on 550 volts, (3) for large capacity such as required by 2-55" or 3-45" magnets in parallel, etc.

The new 2-color folder describing this latest EC&M development gives complete information on the ratings of each controller, dimensions, description of operation, etc., and shows many interesting illustrations of quick drops of the load. Write for a copy to-day.

THE ELECTRIC CONTROLLER & MFG. CO. EC&M CLEVELAND, OHIO

It's adjustable!

Quick Drop of *All Loads* saves time!

To make a lift, the operator simply moves the small lever of this Master Switch to the "Lift" position and, when ready to discharge the load, moves it to the "Drop" position. In this position, the load is released automatically and the controller automatically disconnects the magnet from the line.

Now . . . with this New EC&M Magnet Controller, it is possible to speed up lifting magnet operation by adjusting the controller for a quick, clean drop of all loads. At the start of operation, the operator simply adjusts the controller on the first few lifts to get a fast release. It is not necessary to touch this adjustment again as long as the type of material handled remains about the same and the line voltage remains constant. If he switches to handling a different class of material or to a different size of magnet, or there is a change in line voltage, a small turn of the rheostat-dial sets the controller for a quick release under the new condition. **This is a very simple adjustment and is as easy to make as turning the dial on a radio.**

This is an entirely new controller, having wound-on-edge discharge resistors mounted in ventilated enclosure on top of the cabinet, mill type contactors, and a narrow overall width for easy mounting on rear or side walls of crane cabs. Write for new 2-color folder giving full details.

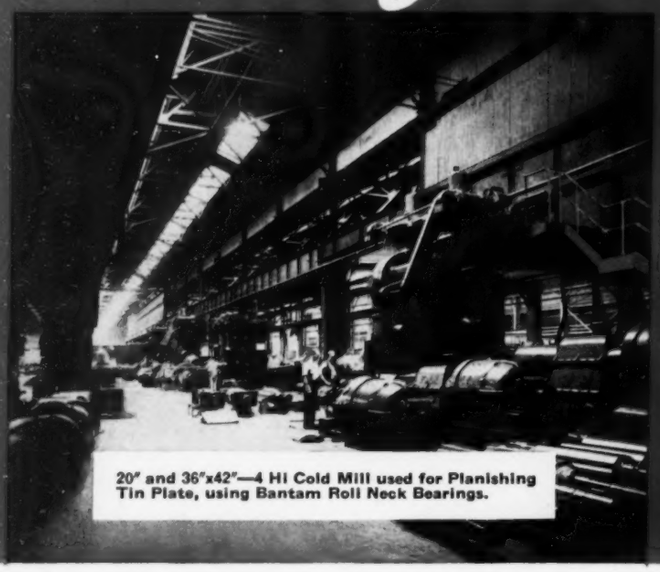
THE ELECTRIC CONTROLLER & MFG. CO.
2700 East 79th St. Cleveland, Ohio

EC&M AUTOMATIC-DISCHARGE MAGNET CONTROLLERS

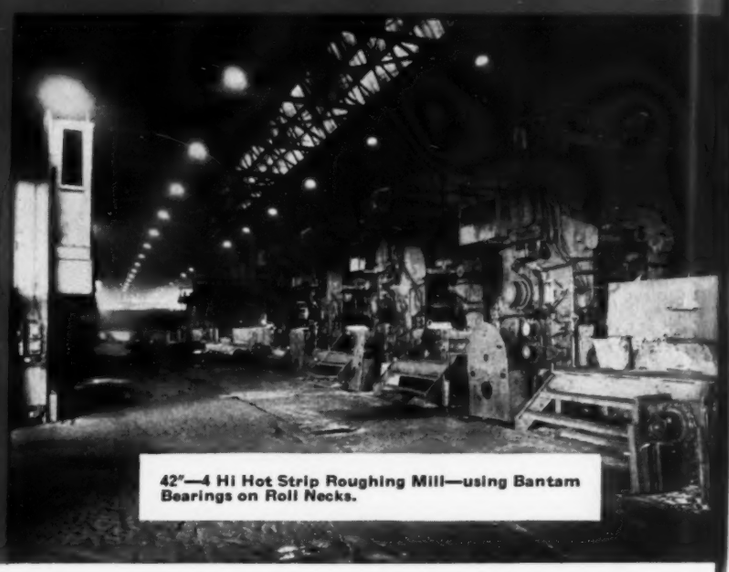
FOR ALL SIZES AND ALL TYPES OF LIFTING MAGNETS

ONLY THE BEST . . .

Bearings Predominate!



20" and 36"x42"—4 Hi Cold Mill used for Planishing Tin Plate, using Bantam Roll Neck Bearings.



42"—4 Hi Hot Strip Roughing Mill—using Bantam Bearings on Roll Necks.

As a result of performance over a period of years Bantam Bearings were selected for the roll necks on the majority of the stands in the world's largest steel plant.

Anything we might say here about our aim to give superior quality, finer workmanship, better engineering or closer tolerances in Bantam Bearing construction would be superfluous. The fact that they are being used on these mills, plus the fact that during the past several years the majority of new mills listed as being equipped with roller bearings have used Bantam, is conclusive proof of the position they now hold.

When you want a new and finer degree of bearing service and satisfaction, use Bantam Bearings. They have well proven their ability to accept responsibility.

BANTAM BEARINGS CORPORATION

SOUTH BEND, INDIANA

SUBSIDIARY OF THE TORRINGTON COMPANY, TORRINGTON, CONN.

BANTAM

TAPERED ROLLER BEARINGS

WAGNER TRANSFORMERS Are Built for SERVICE

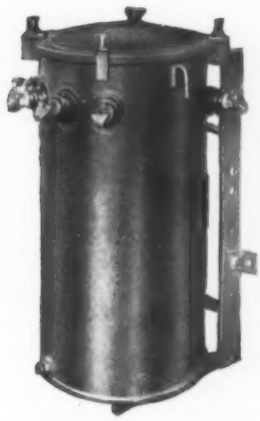
Where Dependable Service Is Essential

Above. Bank of six 200-kva Wagner distribution transformers located in plant of a midwestern steel company. These transformers are equipped with junction boxes on both the high and low voltage sides.

USE Wagner Transformers

Wagner transformers are of sturdy construction and are liberally designed to withstand abuses and to operate at all times at high efficiency. They meet demands for reliable service under all conditions found in the steel industry.

The Wagner line includes every type and size of power and distribution transformers, enabling Wagner to supply all your requirements. Call on Wagner! Forty-six years' experience in the electrical field is at your disposal.



At the left is shown a new Wagner 15-kva, 2400-volt, type HEB stud-bushing-type distribution transformer.

Below. Wagner single-phase, 4000-kva, 69,000 to 2400 volt transformers installed in a large steel plant. Since dust is very prevalent at this plant and may accumulate on the bushings in sufficient quantities to cause normal-rating bushings to flashover, these transformers are furnished with 115-kv high voltage bushings equipped with 69-kv coordinating gaps for use on 69-kv service.

If you desire more information about Wagner Transformers and their desirability for use by the steel industry, write the nearest Wagner branch. Descriptive literature will be sent upon request.

Wagner Electric Corporation

6400 Plymouth Avenue. Saint Louis. U.S.A.

TT237-2F

Visit Wagner Booths No. 173-174 Iron and Steel Exposition Chicago, Illinois Sept. 28-29-30 and Oct. 1

Wagner Transformers Are Noted for Their Reliability and Economy

UNGERER

EDWARD W. VOSS

EXCLUSIVE AMERICAN LICENSEE

UNGERER STRAIGHTENING MACHINES TO BE BUILT IN THIS COUNTRY....

KARL FR. UNGERER, GERMAN DESIGNER AND BUILDER, SELECTS EDWARD W. VOSS TO HEAD UP AMERICAN COMPANY

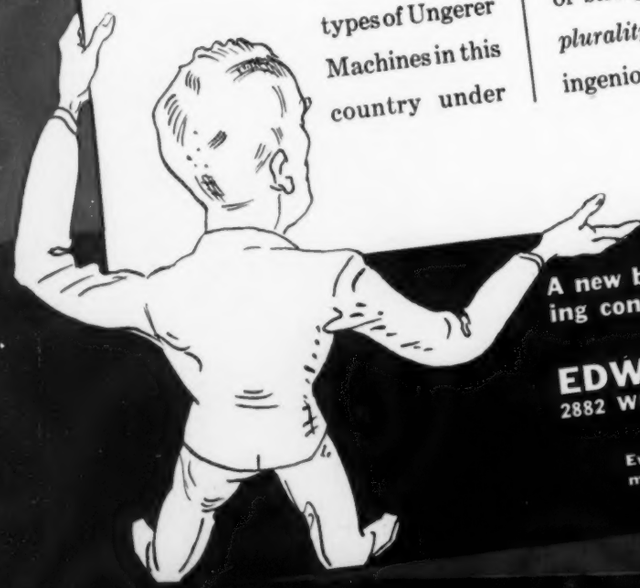
Pittsburgh, Pa., Sept. 15, 1937

Announcement was made here today by Edward W. Voss, Sales Engineer, of an exclusive arrangement that has been made between Karl Fr. Ungerer, well known German inventor and builder of Ungerer Straightening Machines, for plate, sheet and strip mills—whereby Voss will build all types of Ungerer Machines in this country under the Ungerer United States patents.

EDWARD W. VOSS

The Ungerer Machines employ the principle of plurality of straightening rolls, *plus a plurality of supporting rolls*, ingeniously designed and arranged so that accurately controlled continuous pressure may be selectively brought to bear over the entire working area of the machine.

Since 1930 over twenty Ungerer Straightening Machines have been installed in a number of America's foremost mills—all of them rendering highly satisfactory service. Several of the new mills now under construction are also installing these remarkable machines. The superiority of this type of straightening unit has been conclusively proven by their performance in both this country and abroad.



A new bulletin describing all of the Ungerer outstanding construction features and advantages is available through

EDWARD W. VOSS, Sales Engineer

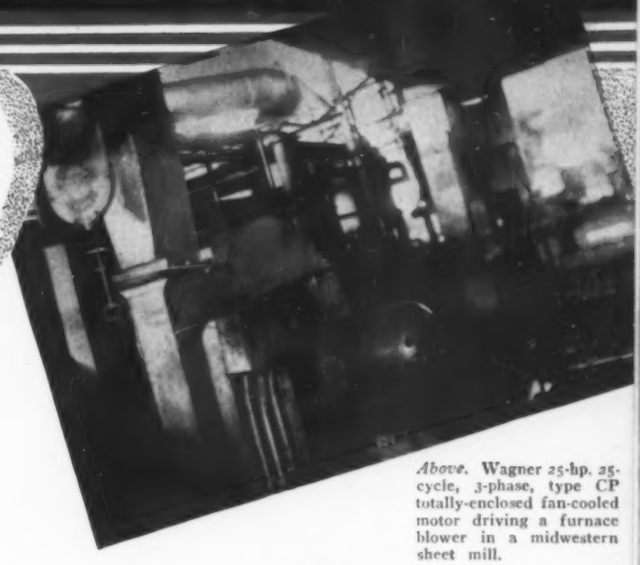
2882 WEST LIBERTY AVENUE . SOUTH HILLS BRANCH

PITTSBURGH, PENNA.

Every user of strip, sheet and plate will be interested in this informative publication. Your inquiries will receive prompt attention.

WAGNER MOTORS Are Built for STRENGTH

Where Dependable Operation Is Essential



Above. Wagner 25-hp, 25-cycle, 3-phase, type CP totally-enclosed fan-cooled motor driving a furnace blower in a midwestern sheet mill.

Use Wagner Motors

Wagner has furnished motors for the steel industry for many years and has continuously improved motors for this purpose. All Wagner motors are built to exacting electrical and mechanical specifications, which embody characteristics and features that give them long life, dependability and added protection against failure. Ruggedness characterizes every detail of their construction. They are particularly noted for their good performance and stamina.

Wagner motors are available with the proper characteristics to fit varying service requirements—being obtainable in all electrical and mechanical types; in single or multi-speed; in totally-enclosed or open frames.

Left. Wagner type CP totally-enclosed fan-cooled motor—ideal for operation in atmospheres laden with dust, fumes, and moisture.

Left. Wagner type RP squirrel-cage polyphase motor—it will meet your requirements of performance and dependability.

Below. Wagner 25-hp, type RP, 25-cycle, polyphase driving an uncoiler. Motor is equipped with double shaft extension, one extension driving uncoiler and the other extension provided with a brake.

Write today for Bulletin 182 which describes all types of Wagner polyphase motors

Visit Wagner Booths No. 173-174 Iron and Steel Exposition Chicago, Illinois Sept. 28-29-30 and Oct. 1

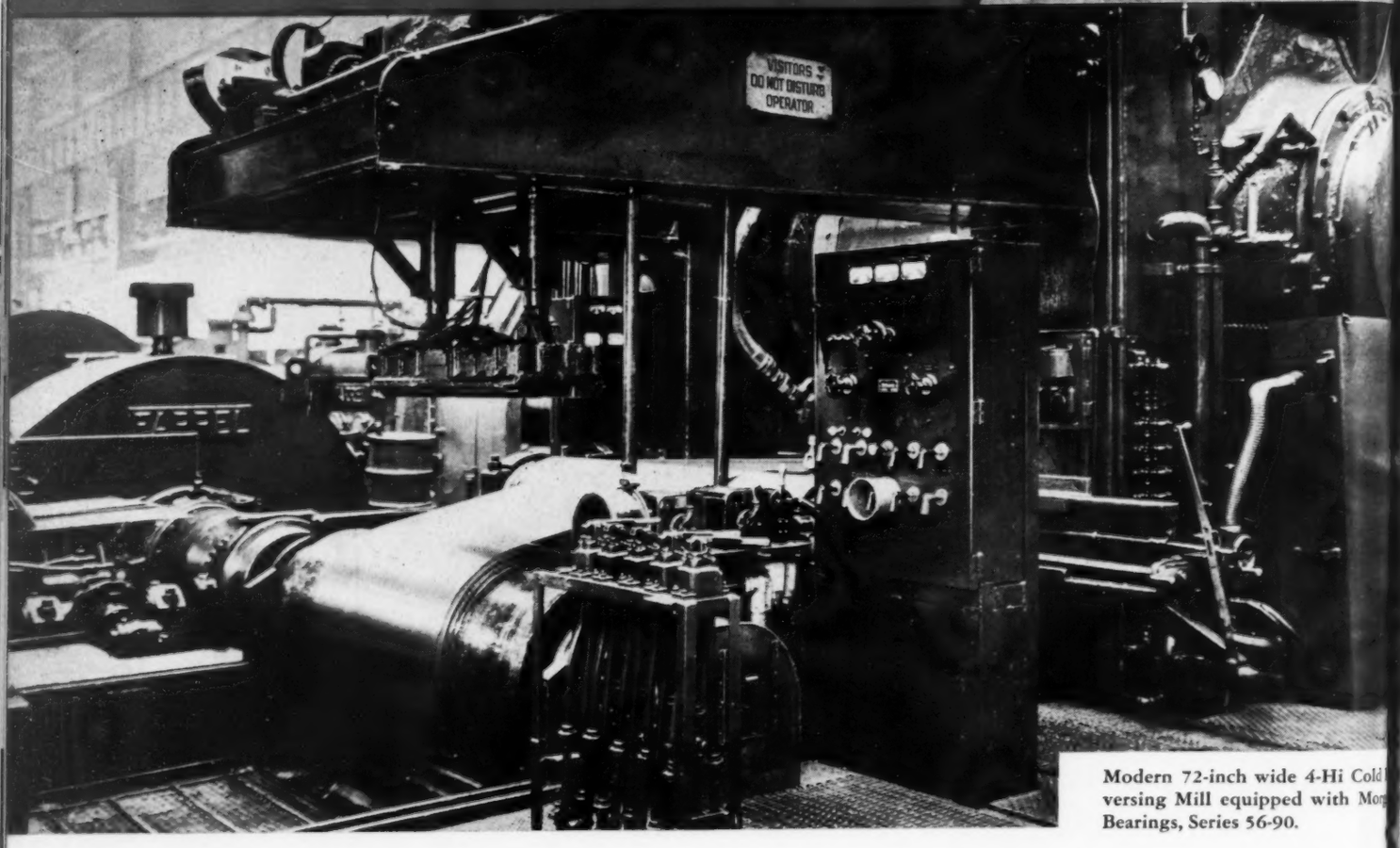
Wagner Electric Corporation

6400 Plymouth Avenue. Saint Louis. U.S.A.

ML237-4F

Wagner Motors Are Noted For Their Good Performance and Dependability

PROVED *Performance*
Positive Maintenance
POWER *Savings*
Precision



Modern 72-inch wide 4-Hi Cold
versing Mill equipped with Mor
Bearings, Series 56-90.

BEARINGS on modern rolling mills must not only be good—they must stay good. Long life with freedom from trouble is absolutely demanded. Accuracy of product is essential, of course. Power savings and low maintenance costs are increasingly important factors. To all these specifications the answer is Morgoil.

Actual service has proved the unsurpassed efficiency of Morgoil Roll Neck Bearings beyond all question. Their wide acceptance by the Rolling Mill industry is the best evidence of highly satisfactory performance in their many applications. They are a typical Morgan development—the product of sound engineering design and constructive skill.

MORGAN CONSTRUCTION COMPANY
Worcester, Massachusetts, U. S. A.

Morgoil MORGAN WORCESTER ENGINEERS AND MANUFACTURERS *Bearing*

R30

The WEAN Engineering Co. Inc
Warren, Ohio.

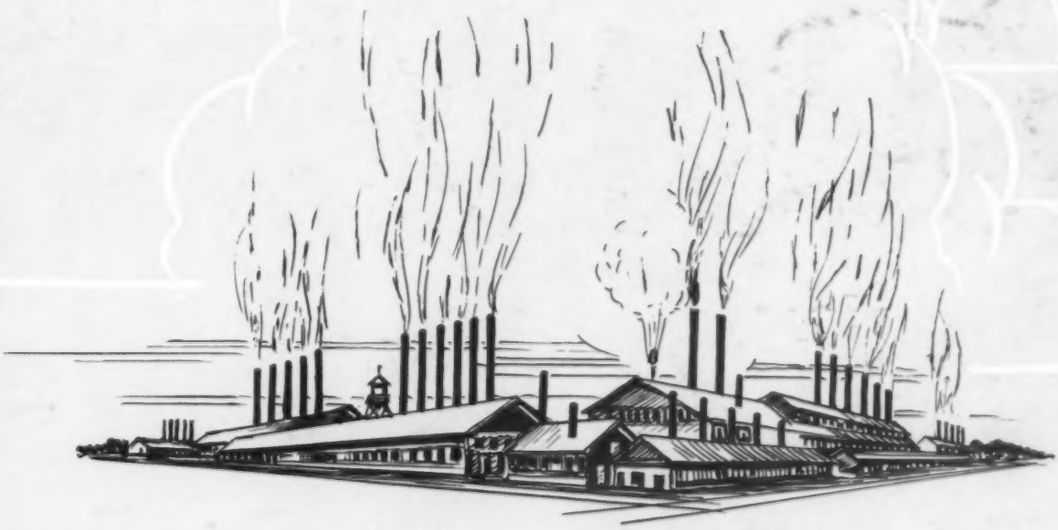
SPECIALISTS IN SHEET-STRIP-AND TIN MILL EQUIPMENT

ASSOCIATE COMPANIES

LEE WILSON ENGINEERING CO.

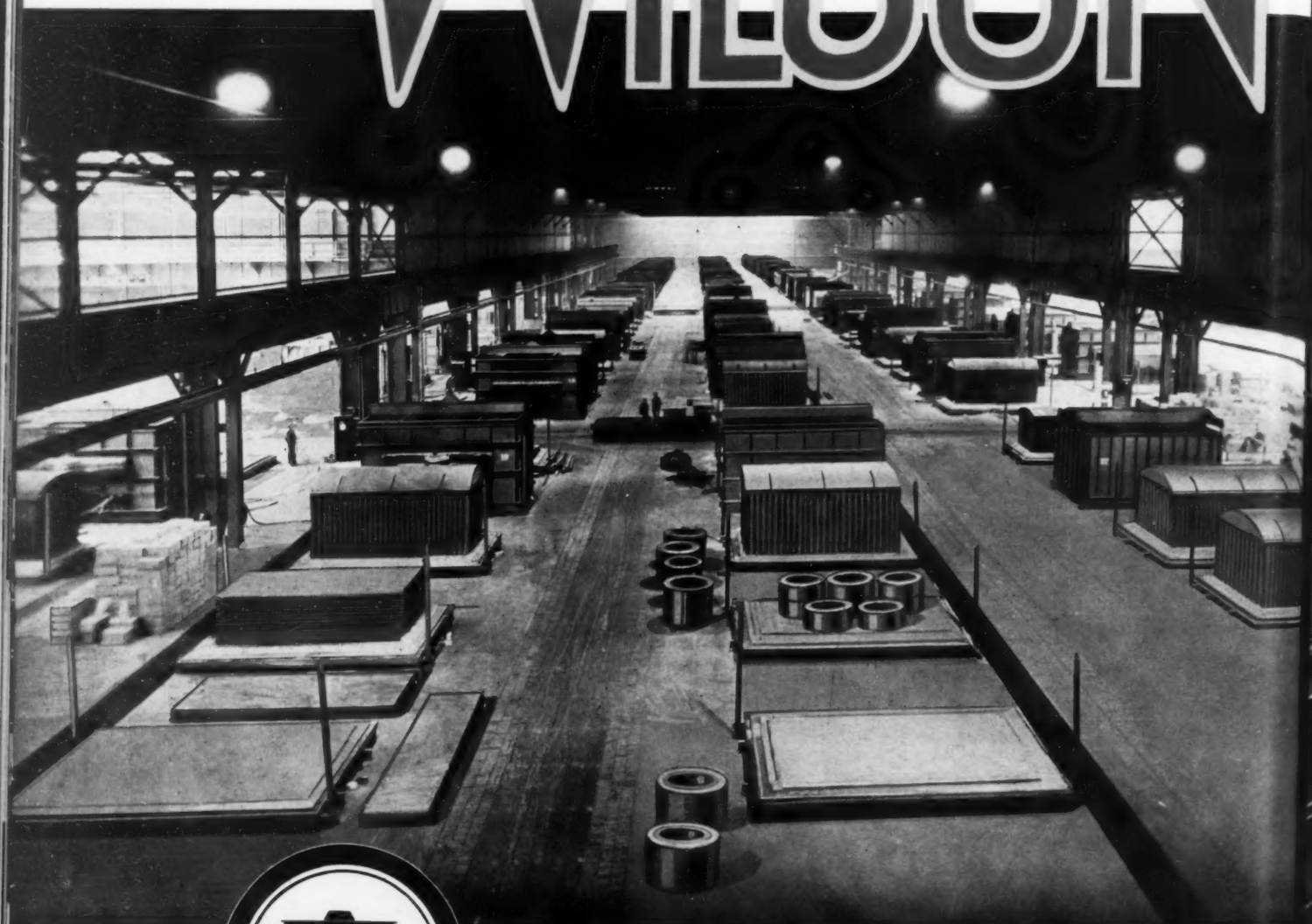
THE McKAY MACHINE COMPANY

FLINN and DREFFEIN COMPANY



LEE WILSON

The Wilson Annealing Unit is covered by patents Nos. 1952402, 2068477, 2078356, 2081612, and other patents pending.



QUALITY ANNEALING, LOW FUEL CO

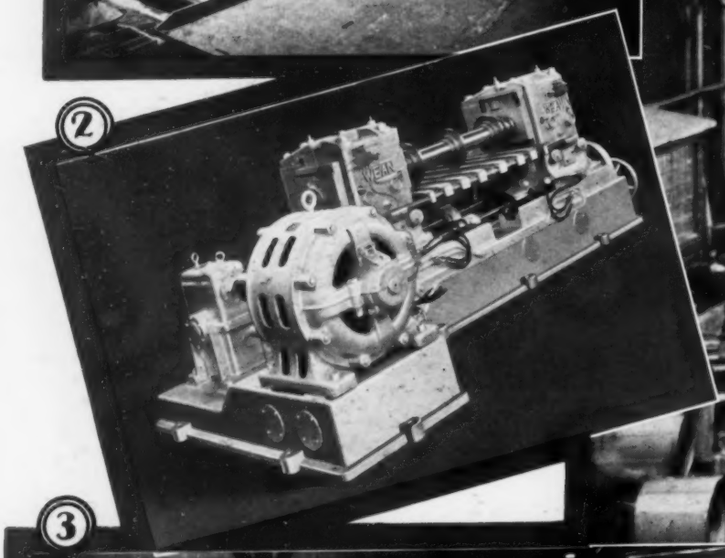
Annealing Equipment ★ *for* THE LARGEST STEEL PLANT IN THE WORLD

Wilson Annealing Furnaces because of their exclusive features — vertical tubes and single tube control — are producing higher quality steel, in shorter annealing cycles, at low cost.

These furnaces satisfy the exacting demands of the largest steel plants.

LEE WILSON ENGINEERING COMPANY
1370 Blount St. Cleveland, O.
Sold by THE WEAN ENGINEERING CO., INC., Warren, O.

WEAN



Wean equipment for the steel industry assures profitable production for each unit of the production line, from the handling of the hot strip coil to the finished product.

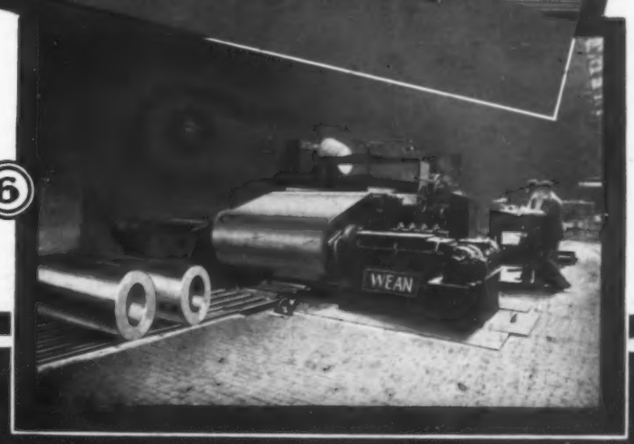
Wean equipment is perfectly synchronized, automatically controlled, efficiently arranged and economical to operate.

1. The Wean-McKay Patented Processing Uncoiler produces strip especially suited for pickling and forming operations.

2. The Wean Slitter and Side Trimmer.

Equipment for THE LARGEST STEEL PLANT IN THE WORLD

SPECIALISTS IN SHEET, STRIP AND TIN MILL EQUIPMENT



4. Installation of Wilson Annealing Furnaces.

5. Wean Wide Strip Reel — overhung type.

THE WEAN ENGINEERING CO., INC.

Warren, Ohio

Associated Companies: Lee Wilson Engineering Co., The McKay Machine Co., Flinn & Dreffein Co.

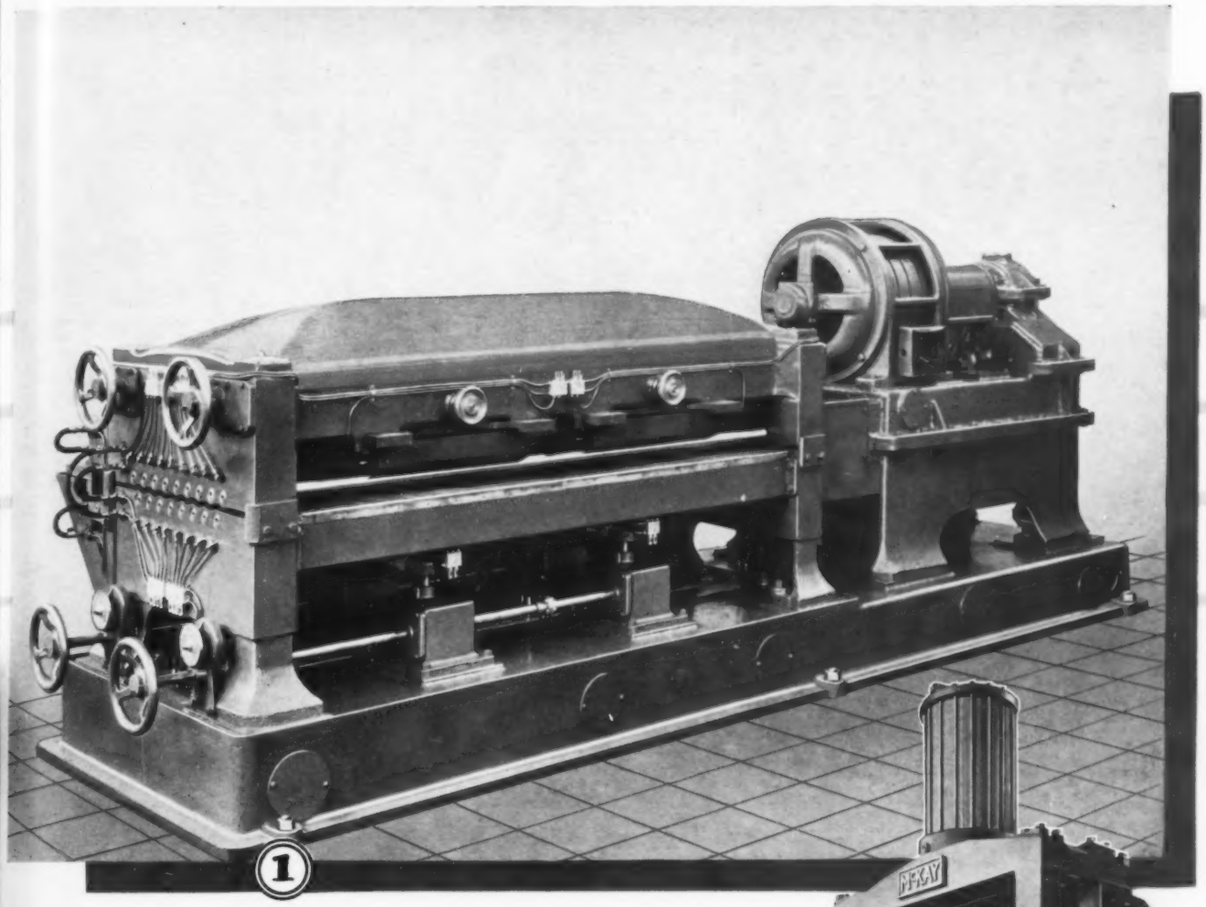
McKAY

Equipment for THE LARGEST STEEL PLANT IN THE WORLD

The photograph below shows four of the six McKay Patented Processing Uncoilers in operation in the largest steel plant in the world.

McKAY

1. The McKay Backed-Up Roller Leveler, because of its extraordinary rigidity, has proven itself superior where accurate flatness is required.



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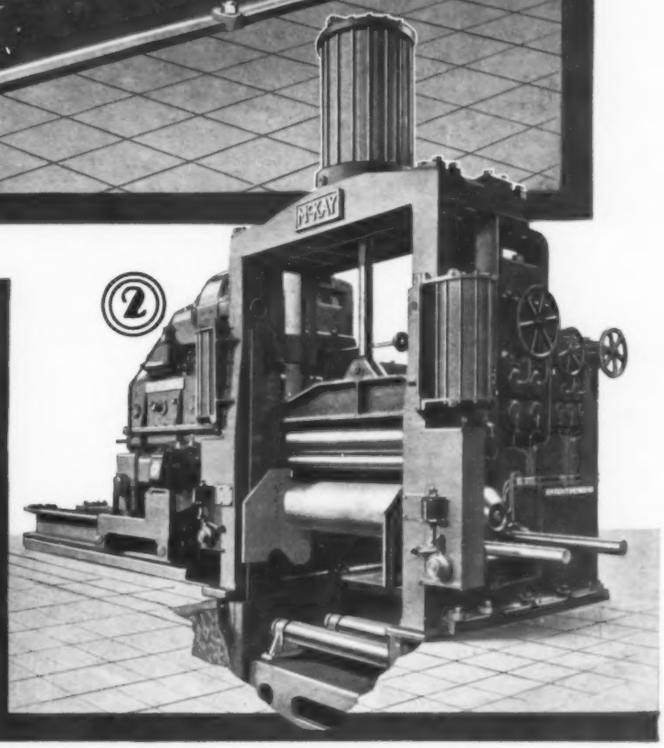

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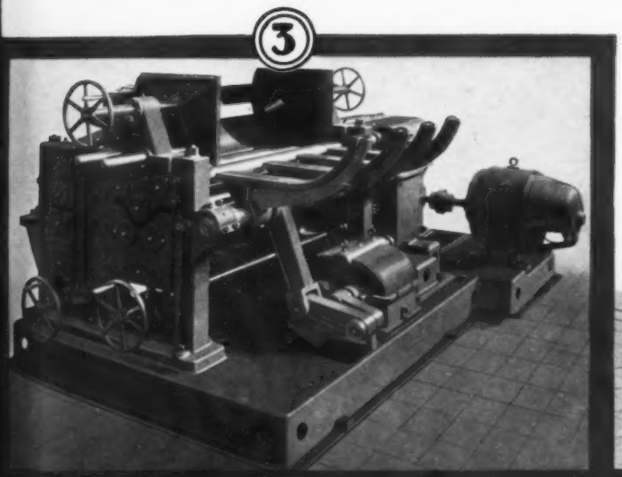

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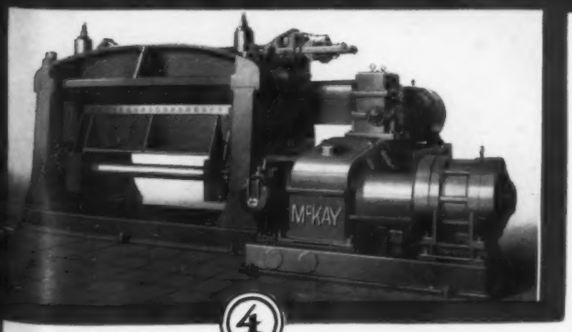


4

2. The McKay Patented Processing Uncoiler produces strip free from objectionable coil breaks, thoroughly ductile and which will not break in forming operations.

3. A standard type of recoiler built to handle 72" wide material, employing a device as shown for lowering the coils for transfer to an adjoining building.

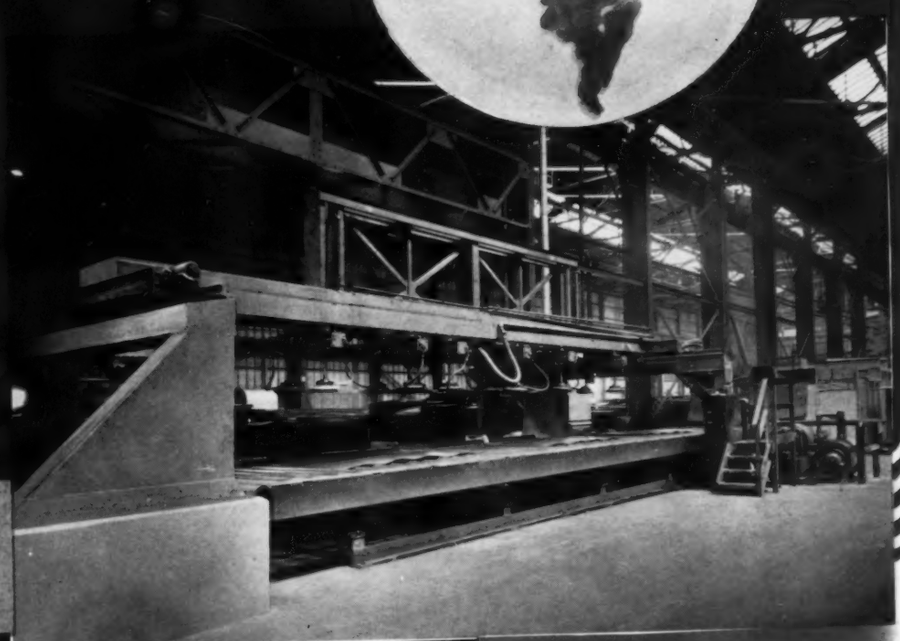
4. The McKay Up-cut Shear, heavy and rugged in design, is used in connection with continuous strip pickling and processing lines.

McKAY

THE McKAY MACHINE COMPANY, Youngstown, O.
Associated Co.— The Wean Engineering Co., Inc., Warren, O.

FLINN and DREFFEIN

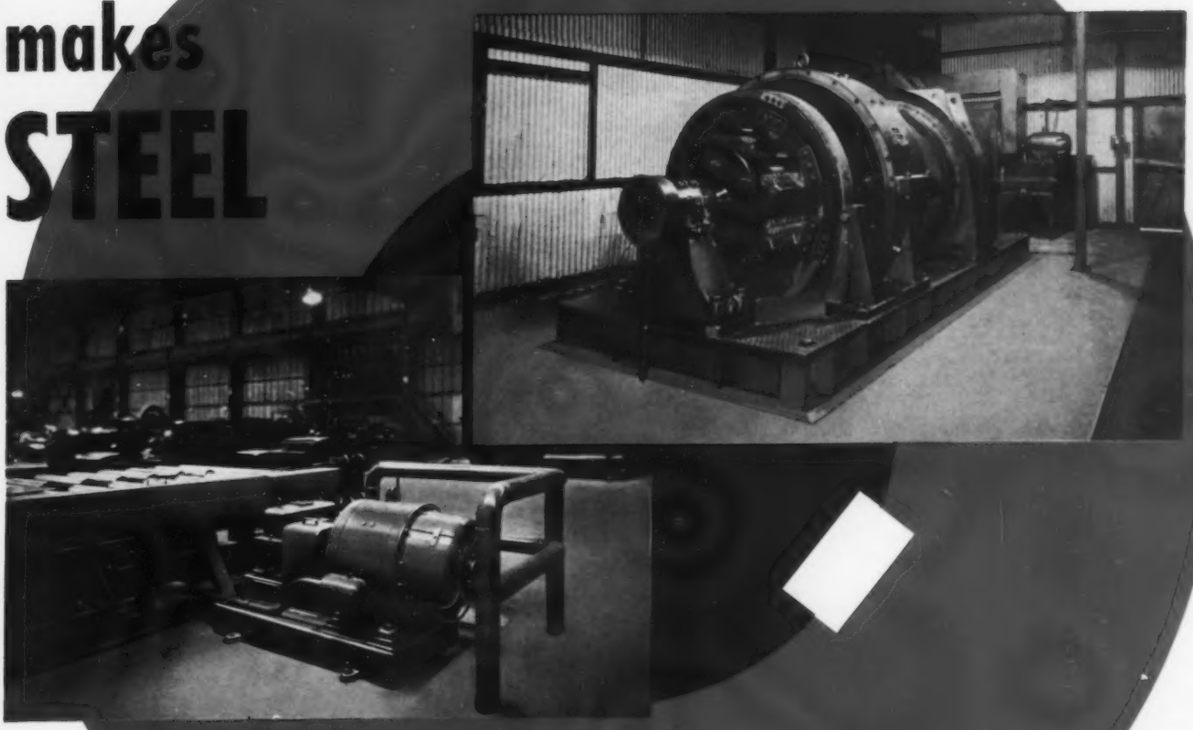
Equipment for THE LARGEST STEEL PLANT IN THE WORLD



FLINN & DREFFEIN CO.
Chicago, Ill.

Associated Co.—
The Wean Engineering Co., Inc.
Warren, O.

CO-OPERATION makes STEEL



THE TIME—1904: The Steel Industry is having trouble finding a motor that will perform satisfactorily. Railway motors are being used without success. The insulation cannot withstand the injurious effects of an atmosphere laden with moisture, dust, and fumes. The motors are not designed for the terrific heat. Crocker-Wheeler offers to design a motor just for the Steel Industry. Steel engineers tell what they want. The motor is built and proves a success. Co-operation.

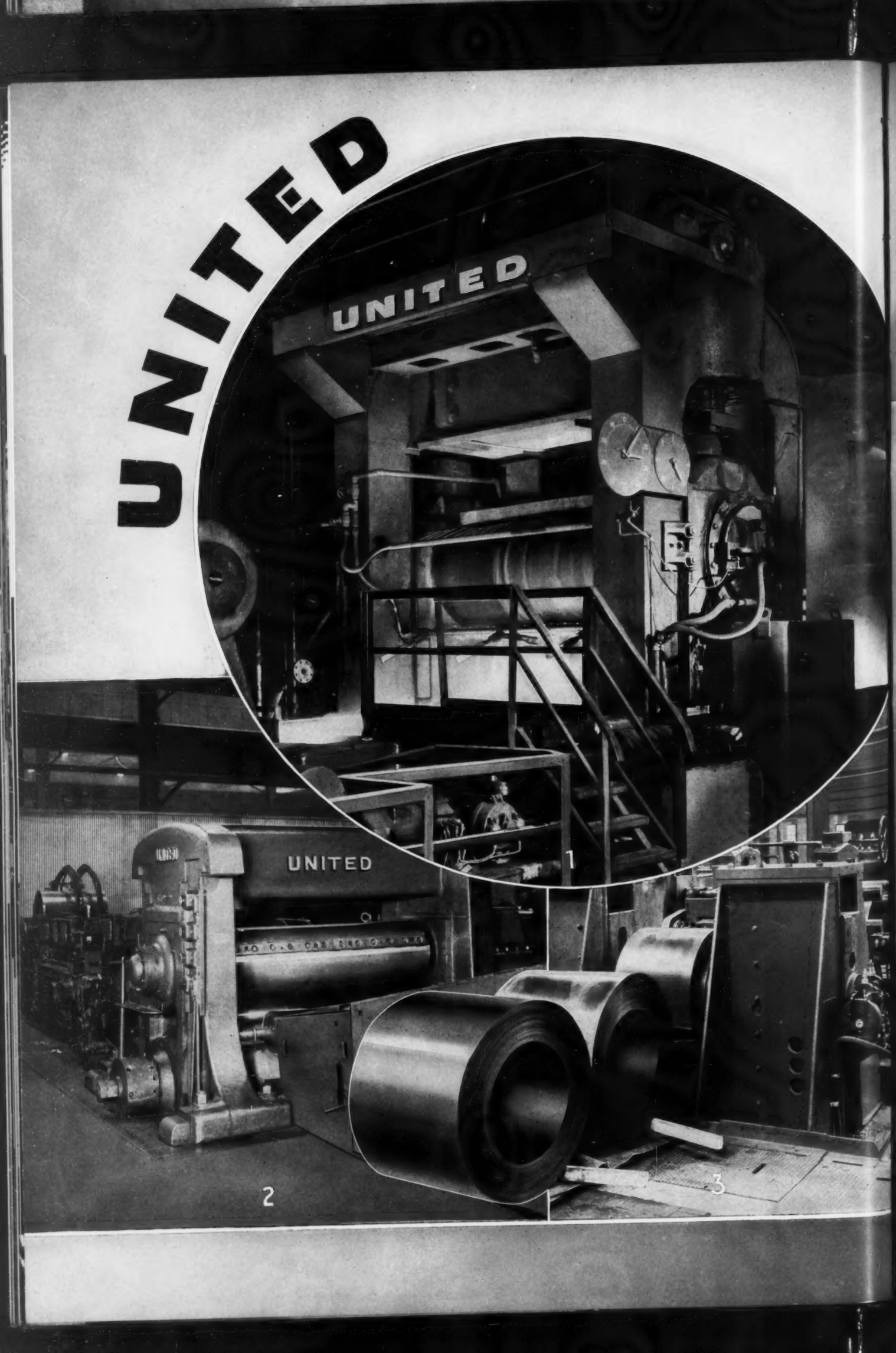
THE TIME—TODAY: A new 80-inch, hot-strip mill is turning out steel at a speed impossible to visualize thirty-three years ago. Crocker-Wheeler continues to co-operate by building each motor, each generator, each motor-generator set for its particular job. Whether it is (1) a 1000 kw. motor-generator set or (2) a 15 hp. motor to drive a shear line, you know that if it is "Crocker-Wheeler" it was built to suit its application.

Visit booth 177 at the Iron and Steel Exposition.

CROCKER-WHEELER
TRADE MARK REG. U.S. PAT. OFF.

EXCELLENT ENGINEERING

CROCKER-WHEELER ELEC. MFG. CO.
Main Office and Works: AMPERE, N. J.
SALES OFFICES IN PRINCIPAL CITIES


UNITED
UNITED
UNITED
1
2
3

COMPLETE ROLLING MILL *Equipment*

During the Association of Iron and Steel Engineers' inspection trip, you will see UNITED Hot and Cold Strip Mills, shearing lines, cleaning lines, and other processing equipment in operation.

1

40" & 54" x 130" Broadside Mill Stand of 80" Continuous Hot Strip Mill

2

76" Drum Type Flying Shear

3

Cone Type Uncoiler at entry end of Tin Plate Shearing Line

4

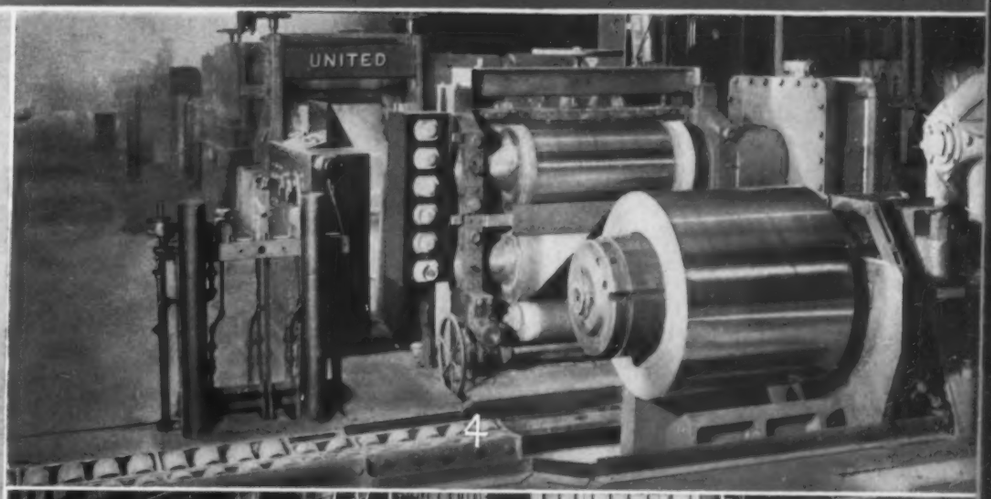
Delivery end of Tin Plate Electrolytic Cleaning Line

5

76" Reciprocating Flying Shear Line

6

Standard Reciprocating Tin Plate Flying Shear



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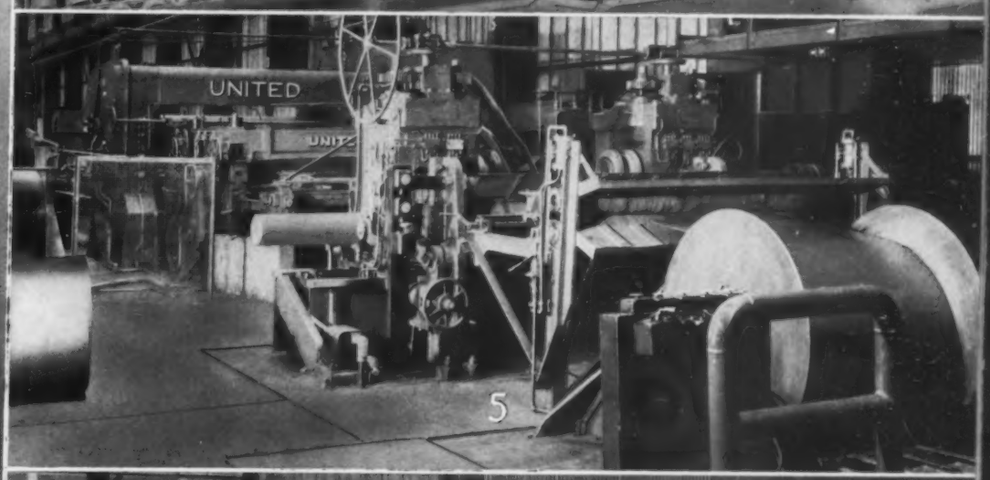

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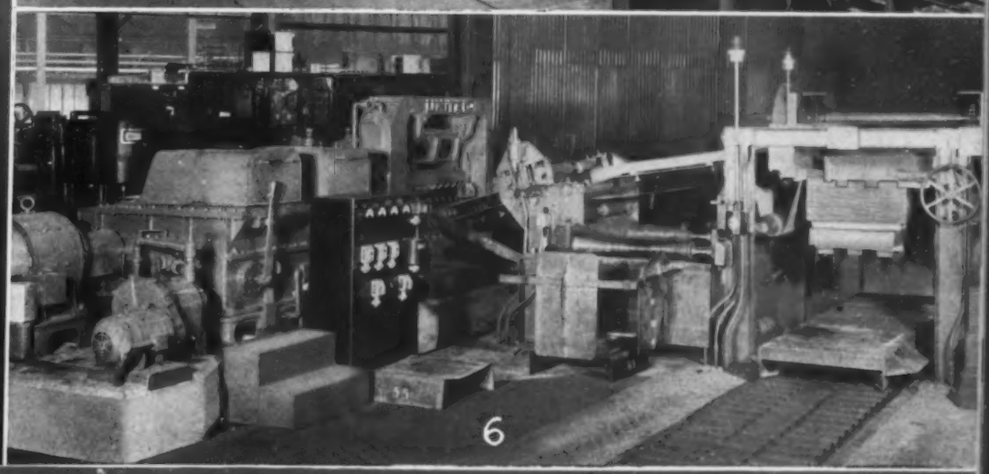


6

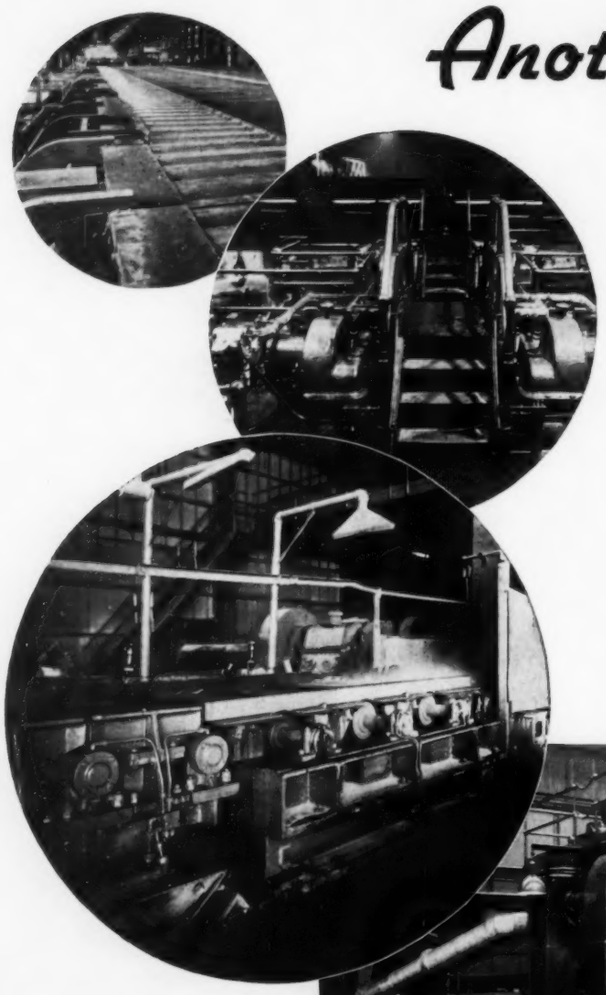
UNITED
ENGINEERING and FOUNDRY COMPANY
PITTSBURGH — PENNSYLVANIA

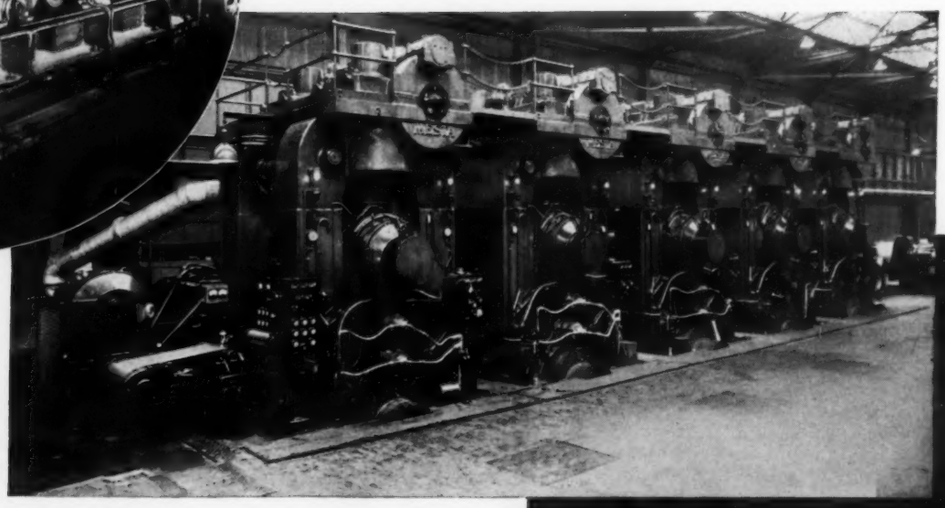
Associated Companies

DAVY and UNITED ENGINEERING CO., LTD.
SHEFFIELD · ENGLAND

DOMINION ENGINEERING WORKS, LTD.
MONTREAL · P. Q.

Another MODERN SKF-





More than 20 tons of SKF Spherical Roller Bearings are used on applications pictured and described here. In addition, hundreds of SKF Bearings are used in cranes and processing and auxiliary equipment. This widespread use of SKF Spherical Roller Bearings is due to a desire to obtain an equalized load distribution insuring full bearing capacity and long life. SKF Industries, Inc., Front Street and Erie Avenue, Philadelphia, Pa.

SKF

69

STRIP MILL uses equipped machines

AGAIN SKF Spherical Roller Bearings assure real performance to a modern strip mill.

CONTINENTAL ROLL & STEEL FOUNDRY COMPANY built the 3-stand tandem 20-½"x 56"x 84" cold mill, and the design of the screwdowns required 12 SKF Bearings per stand.

MESTA MACHINE COMPANY supplied two 5-stand tandem 42" wide cold mills with one SKF Bearing to stabilize each back-up roll.

E. W. BLISS COMPANY used SKF Bearings and Pillow Blocks for the individually driven table rollers, transfer chain line shafting and idler sprockets in the cooling beds for the hot strip mill.

CONTINENTAL ROLL & STEEL FOUNDRY COMPANY equipped the hot mill rollers between stands and in the shear table with SKF Bearings mounted in SAF Type Pillow Blocks. The screw-downs of the hot strip mill tandem stands are 100% equipped with SKF Bearings.

FALK CORPORATION built one 800 h.p. double reduction and three 4500 h.p. single reduction drives. All bearings are SKF Bearings.

3972

IF YOU CHOSE, YOU COULD TURN

THE GAUGE TO THE WALL !

A typical Hagan Control Installation in a large steel mill

IN the Hagan System, instruments are merely *proof* of efficient combustion control—not part of it. The control itself *determines* what is going on; the instruments simply furnish a visual record of what has happened.

You could turn them face to the wall, except for their valuable function of indicating any change from the desirable. And *that* they do straight-forwardly and honestly, without pre-supposing that any one factor is basically responsible for a change which they indicate.

Make no mistake about it, the CONTROL is the thing . . . the accurate automatic adjustment of every combustion factor that is characteristic of Hagan installations all over the world. Twenty years of pioneering leadership place Hagan *first* in the consideration of anyone planning a modern combustion-control installation.

World's Largest Steel Plant—Gary—uses Hagan Controls on Blast Furnace Power Plants and Blast Furnace Boiler House (oil burner, damper or regulator control) and in Sheet Mill Boiler House (damper control).

HAGAN COMBUSTION CONTROL

HAGAN CORPORATION

300 ROSS STREET, PITTSBURGH, PENNA.

IN THE STEEL INDUSTRY

The key to economy and production efficiency in the Steel Industry centers upon the very definite factor of uninterrupted operation. Thus, CUNO *Continuously Cleanable* FILTERS are a natural choice. Shown here, as installed by DeLaval on the lubricating system of a 100" semi-continuous sheared plate mill, the CUNO Auto-Klean FILTER handles 460 GPM of Mineral Oil, 2300 SSU @ 100°F.

CUNO *Continuously Cleanable* FILTERS

—speed up and make a continuous operation, as well, of the filtration of soluble cutting oils and coolants, greases, fuel tar, lubricating and fuel oils. And, they perform equally notable functions guarding descaling spray and roll body coolant nozzles against stoppage due to foreign solids.

Let us tell you how CUNO *Continuously Cleanable* FILTRATION can show YOU important operating economies. Ask for Bulletin.

SEE THE CUNO EXHIBIT AT THE IRON & STEEL EXPOSITION, HOTEL STEVENS, CHICAGO, BOOTH 198 BALLROOM FLOOR

CUNO

ENGINEERED FILTRATION

CUNO ENGINEERING CORPORATION · MERIDEN, CONN.

CUNO ENGINEERING CORP.,
Dept. 90, 595 So. Vine St.,
Meriden, Conn.
Gentlemen: Please send me without obligation bulletin of CUNO FILTERS for service on

_____

_____

and information on your engineering service.

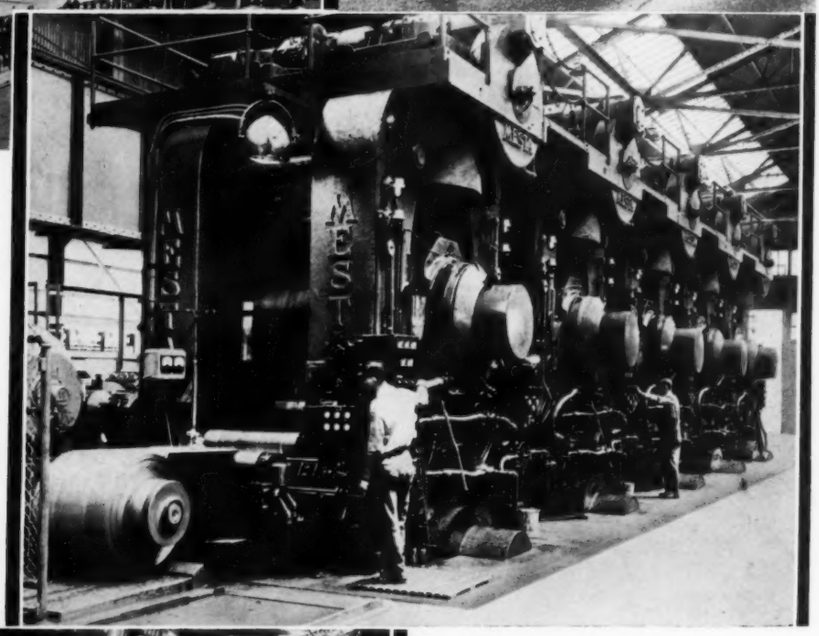
Name _____

Address _____

City & State _____

MESTA

Mesta 160" Three High Plate Mill with Tilting Tables



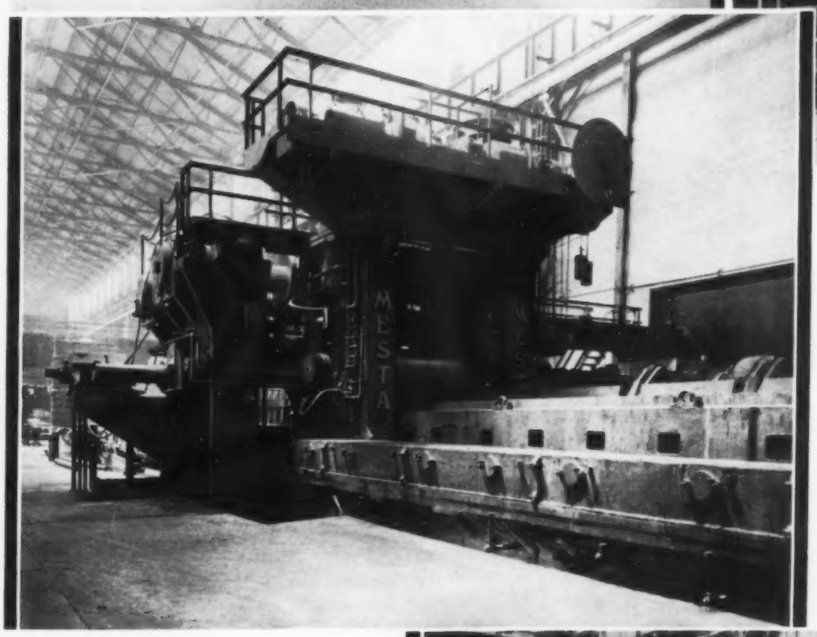
Mesta 42" Four High Five Stand Tandem Cold Mill for Rolling Tin Plate Gauges

Mesta-Meaker Electrolytic Cleaning and Processing Unit for Tin Plate Gauges, designed for Use with Mesta Patented Flying Shear or Rewinder

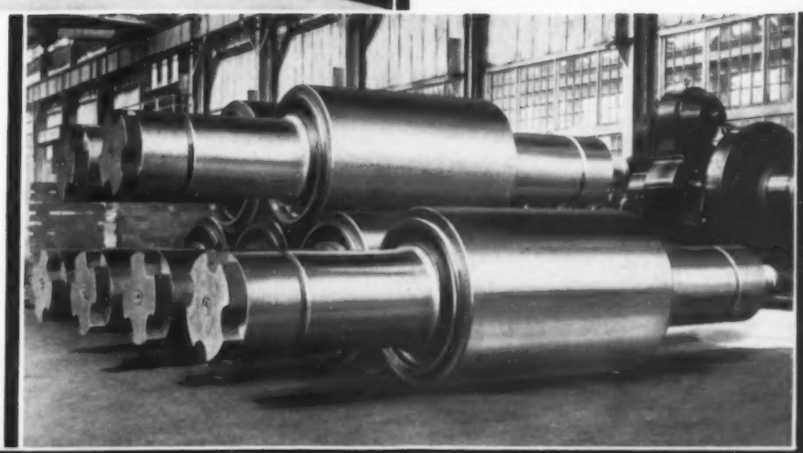
★ MESTA MACHINE COMPANY

DESIGNERS and BUILDERS *of Complete* STEEL MILL EQUIPMENT

Mesta 40" Reversing Blooming Mill, with Mesta Manipulator and Tables



Mesta 44" x 96" Universal Slabbing Mill, with Mesta Manipulator and Tables



Mesta Heat Treated Special Alloy Steel Backing Up Rolls for Four High Mills

PITTSBURGH, PENNSYLVANIA ★

THROUGHOUT THE STEEL INDUSTRY

• POOLE •

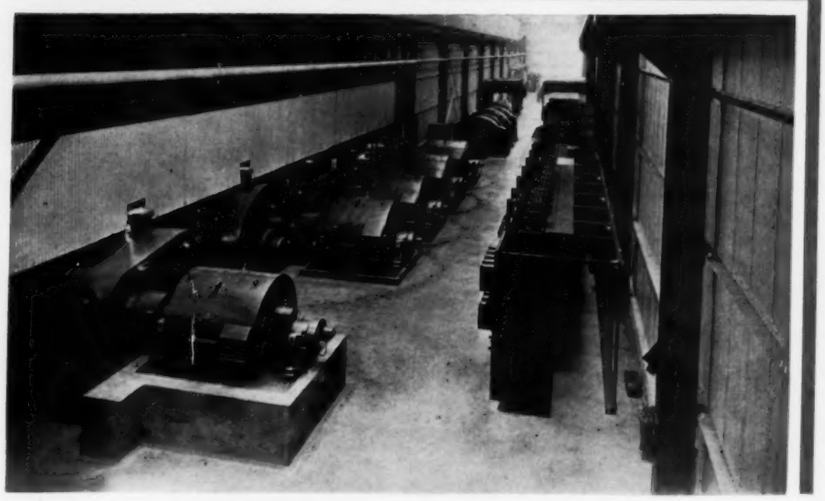
FLEXIBLE COUPLINGS

Look at these features—many of them exclusive with the patented Poole:

Adjusts itself to all conditions, leaving its members free to float without strain to parts.

Geared type providing great strength, the highest efficiency of modern flexible coupling design.

No flexing materials to crystalize or break... No welded parts... Filled with oil, self lubricating... Oil tight, dust tight . . . Permits free lateral float . . . Stronger than shafts it connects . . . Compensates for both off-set and angular misalignment.



FINISHING MILL DRIVES

Get the whole story from our handbook, "Flexible Couplings." A copy will be gladly sent without obligation. This book should be in the hands of all "Steel men."

the better

FLEXIBLE COUPLING

Visit our exhibit Booth 205 Iron & Steel Exposition, Chicago, Illinois, September 28 to October 1, 1937.

Poole Foundry & Machine Company

Baltimore, Maryland

FOR HEAVY DUTY SERVICE SUCH AS THIS MILL DRIVE EQUIPMENT

Use "SA" Series Brushes

They possess the necessary stamina to withstand severe peak loads and emergency demands.

They have set new standards of uniformity in performance as well as in physical properties.

They improve commutation under difficult conditions.

They Reduce Operating And Maintenance Expense.

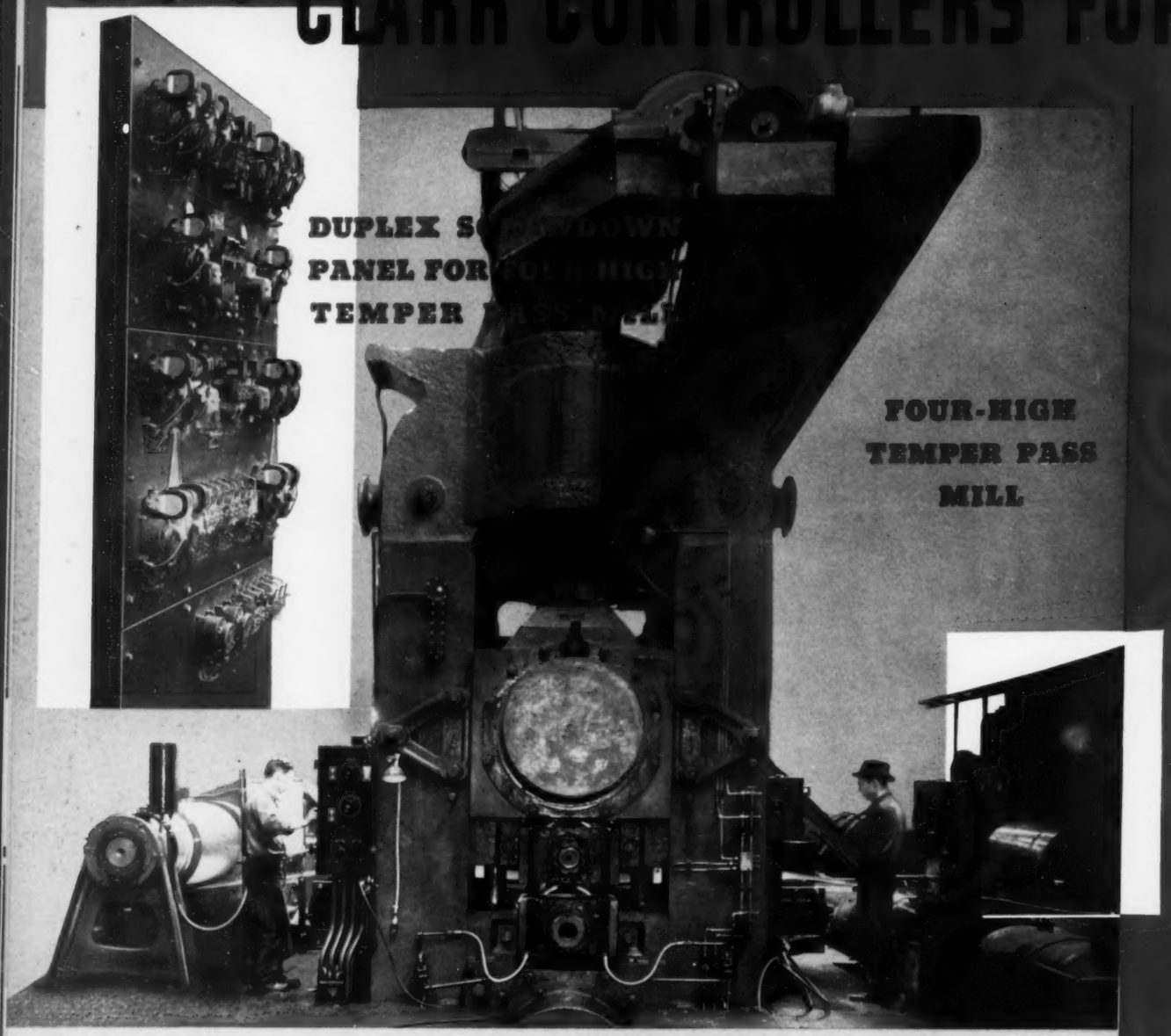
NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

Carbon Sales Division: Cleveland, Ohio General Offices: 30 East 42nd Street, New York, N.Y.

BRANCH OFFICES: NEW YORK PITTSBURGH CHICAGO SAN FRANCISCO

CLARK CONTROLLERS FOR



Tons of steel castings withstanding crushing pressures —yet so accurately built that steel strips passing through the rolls are uniform and even—this calls for accurate control. • Clark "3C" Screwdown Panels for Temper Pass Mills provide steady, consistent control for production of steel of uniform thickness. • Built to high precision standards, Clark "3C" Heavy Duty Mill controls give long-time, dependable service that speeds continuous production.

Our nearest office is at your command.

THE CLARK CONTROLLER COMPANY

1146 EAST 152ND STREET • CLEVELAND, OHIO

AKRON • BALTIMORE • BIRMINGHAM • BOSTON • BUFFALO
CHICAGO • CHATTANOOGA • CINCINNATI • CLEVELAND
DALLAS • DENVER • DETROIT • LOS ANGELES • MINNEAPOLIS
NEW ORLEANS • NEW YORK • PHILADELPHIA • PITTSBURGH
ST. LOUIS • SAN FRANCISCO • SEATTLE • TORONTO

CONTINUOUS PRODUCTION

FOUR PICKLING LINES

● To still the insatiable appetite of long pickling lines, flows a constant stream of strip steel. This 24 hour per day continuous pickling process demands dependable controls that function day in and day out, for months and years.

Into Clark "3C" controls is built wear-resisting apparatus that stands up under the steady grind . . . giving satisfactory service for uninterrupted production.

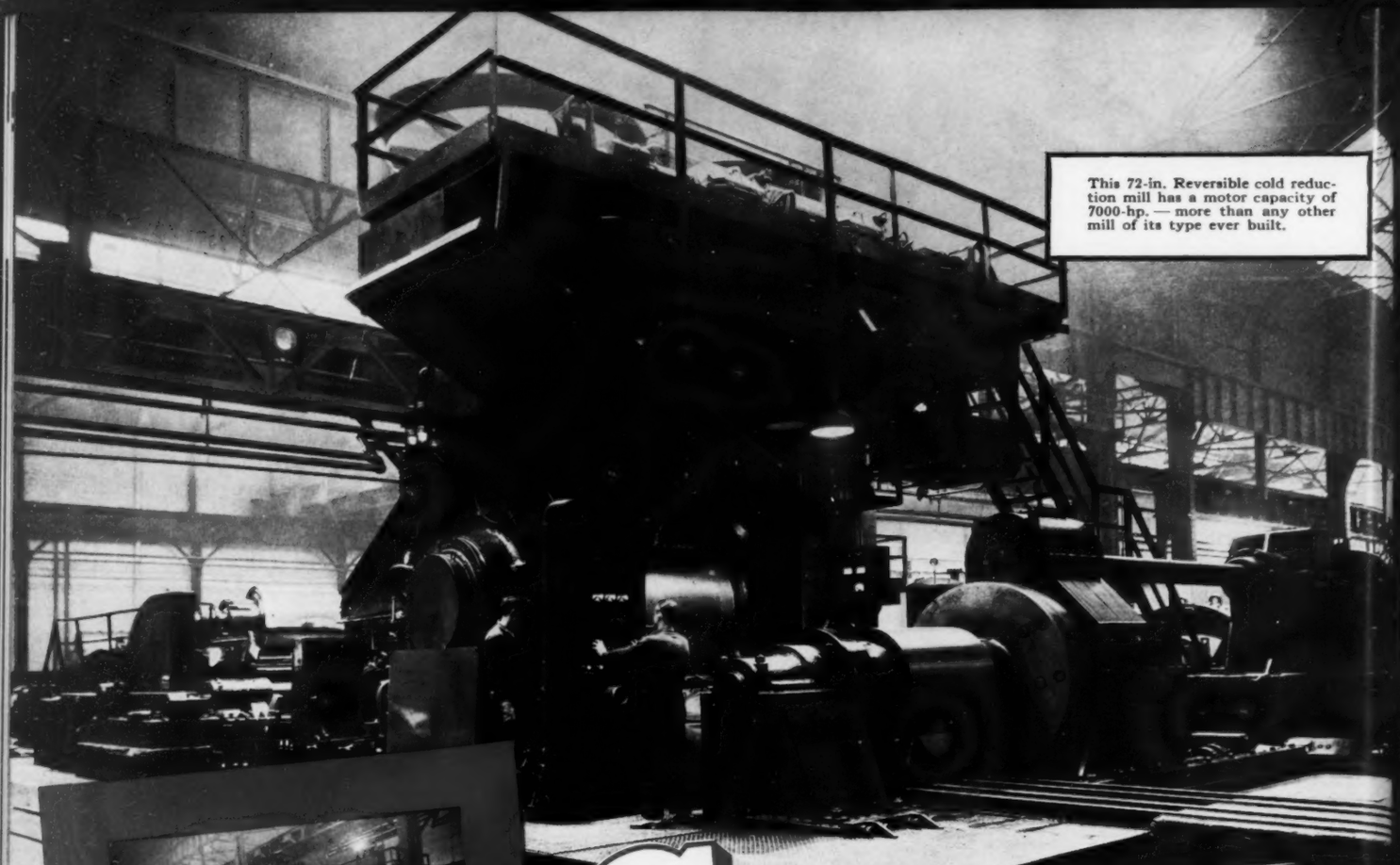
Your heavy duty mill control problems can be simplified and solved with Clark "3C" Controls.

PICKLING LINE CONTROL ROOM

"CLARK 3C" RHEOSTATS • "3C" BRAKES • "3C" A.C. STARTERS • "3C" CONTACTORS • "3C" SQUIRREL CAGE MOTORS • "3C" D.C. STARTERS • CRANE CONTROLLERS • CRANE PROTECTIVE PANELS • BATTERY CHARGING PANELS • AUXILIARY ELECTRICAL EQUIPMENT

THE CLARK CONTROLLER COMPANY

1146 EAST 152ND STREET • CLEVELAND, OHIO



This 72-in. Reversible cold reduction mill has a motor capacity of 7000-hp. — more than any other mill of its type ever built.

GREATEST POWER

EVER APPLIED TO A REVERSING COLD MILL

The main rolls of the 72-inch mill are driven by this 4000-hp., 150-300-rpm. Westinghouse motor.

One of the two 750-1500-rpm. reversing driving the reels. Long, small-diameter armatures keep inertia of these motors at a minimum.

This Westinghouse switchboard constitutes the control for the world's most powerful single-stand reversing cold mill.

Seven thousand horsepower — that's the motor capacity on this 72-inch reversing cold strip mill. Made up of a main roll drive motor of 4000-hp. capacity, and two 1500-hp. motors for reel drive, this mill is the most powerful of its type ever built.

Cold reduction in this mill is accomplished by both roll pressure and tension. Forward tensions of around 150,000 lbs. are possible, while back tensions as high as 200,000 lbs. can be developed.

Whatever the problem of your mill may be, its electrical phases can be solved with Westinghouse equipment, or by the ingenuity of Westinghouse steel mill engineers. Call on them for your every electrical requirement.

J 93250

Westinghouse Elec. & Mfg. Company, East Pittsburgh, Pa.

UNDIVIDED RESPONSIBILITY MULTIPLIES THE VALUE of WESTINGHOUSE SERVICE

W WESTINGHOUSE ELECTRIC

FROM POWER SUPPLY TO DRIVEN MACHINE

Specify **Westinghouse**

MOLONEY TRANSFORMER INSTALLATION
3—20,000 Kva forced-air cooled,
15,000 Kva self-cooled, 3 phase,
60 cycle transformers.
132,000 volts high to 6600 volts low.

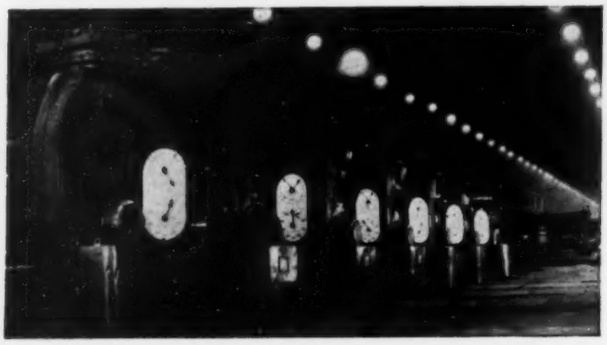
Moloney Serves Steel

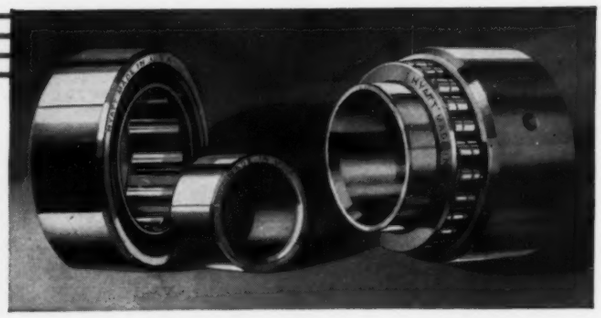
THESE Moloney Transformers are doing their bit toward aiding the steel industry to supply the enormous demand for steel. Steel men need dependable transformers to supply the tremendous amount of power required to keep their mills running at top speed . . . that is why they

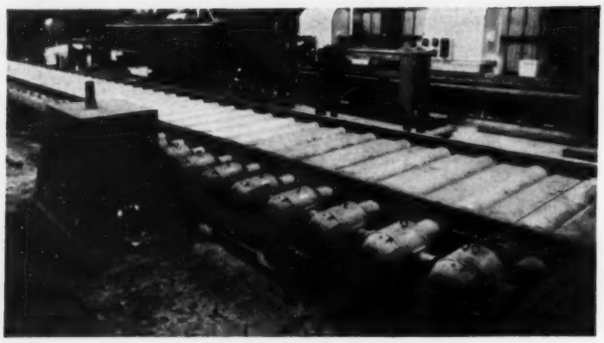
Specify MOLONEY TRANSFORMERS

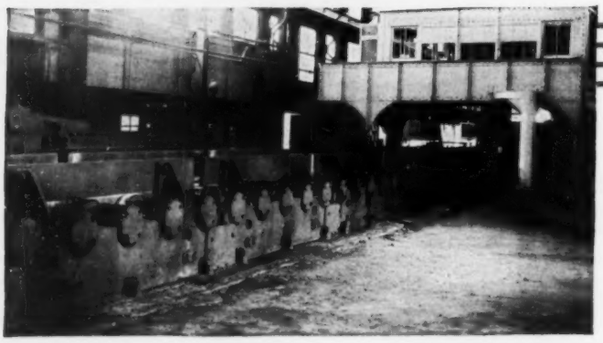
MOLONEY ELECTRIC
SAINT LOUIS
TRANSFORMERS

HYATT *Roller Bearings*









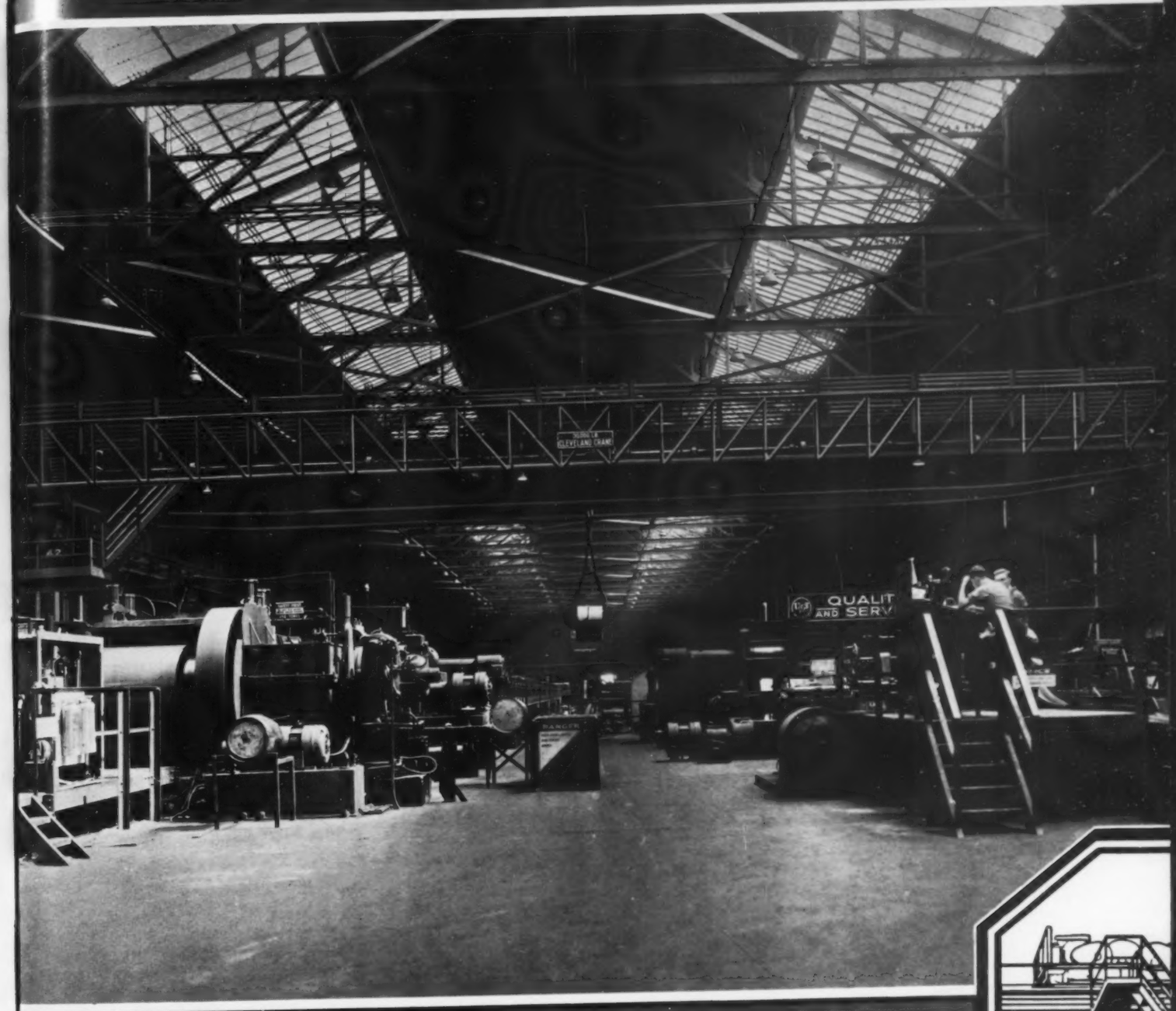
Proved by Performance

In "The World's Largest Steel Plant," as in every modern mill, Hyatt Roller Bearings are everywhere.

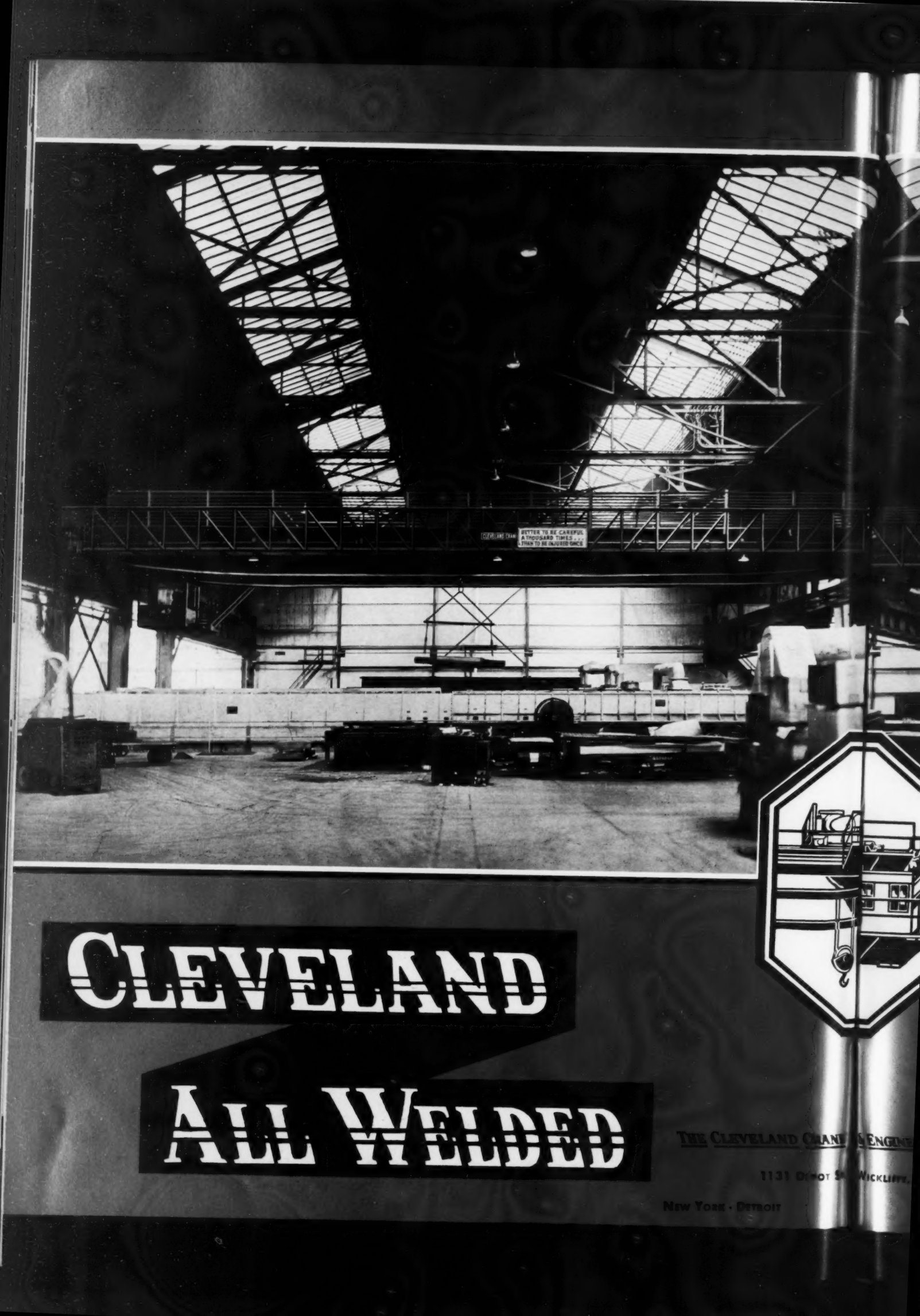
For better operation, longer equipment life, and freedom from wear and care Hyatt Roller Bearings are part of the picture because that's what they are designed and built to do—serve and save.

On their proved performance—in tables, cranes, motors, cars, and auxiliary equipment—Hyatt Roller Bearings have won such widespread use in steel mills.

● At the Iron & Steel Exposition visit the Hyatt Exhibit—Spaces 214 and 215. Hyatt Bearings Division, General Motors Corporation, Newark, Detroit, San Francisco. Hyatt Roller Bearing Sales Company, Chicago and Pittsburgh.



CLEVELAND
ALL WELDED
STEEL MILL
CRANES



CLEVELAND

ALL WELDED

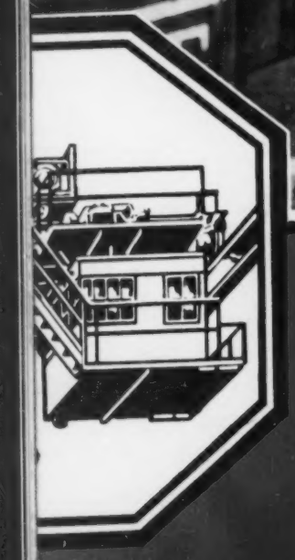
THE CLEVELAND CRANE & ENGINE

1131 DIXIOT ST. WICKLIFFE,

NEW YORK · DETROIT

STEEL MILL CRANES

CRANE ENGINEERING CO.
SPOT STS. WICKLIFFE, OHIO
PITTSBURGH · CHICAGO



CLEVELAND
ALL WELDED
STEEL MILL
CRANES

Below is illustrated conclusive proof of "AUTOMATIC" Leadership to anticipate Modern Production plus expert experience to design and build completely new Heavy Duty Equipment.

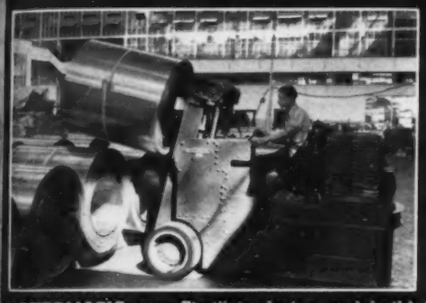
*Of Greater Capacity — for increased tonnage transportation at lowest cost.

*Completely equipped with every proven "AUTOMATIC" feature:

— For Utmost Efficiency and Economy.
— For Dependable Performance.
— For Maximum Safety with speed.
— For Most Flexible Operation.

STEEL MEN HERE'S A RECORD YOU CAN PROFIT BY

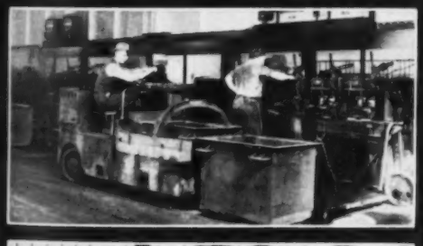
All "AUTOMATICS" are designed and built in this large modern plant at Chicago.



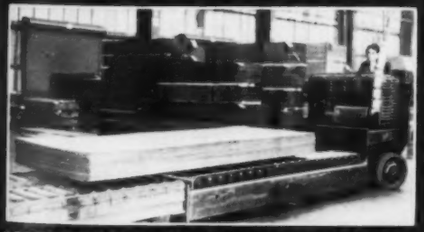
"AUTOMATIC was First" to design and build the most compact Ram and Fork Tractor having all these features:

Shortest overall length and turning radius for greatest flexibility and ease of operation.
Center control for safe clear vision driving.
Front wheel drive for greater traction.
Rear wheel Power Steer for quick right angle pick up.
Uniform load distribution for low center of gravity and stability, plus Tilting uprights for safety in handling.

"AUTOMATIC was First" to develop and build a Heavy Duty traveling motorized upender on an industrial center control tractor—to afford new opportunities for more flexible and economical handling of strip steel coils during the process of manufacture.

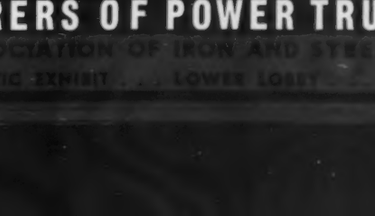


"AUTOMATIC was First" to design and build a Heavy Duty Center Control Bosh Truck for more efficient storage and safer transportation of bosh tanks in connection with the process of producing tin plate.



"AUTOMATIC is First Again" to design and build a Compact Extra Heavy Duty Center Control Ram Tractor with a capacity of 25,000 lbs. or 12½ tons to effect new economies in the production of heavy strip steel coils of special widths and weights.

"AUTOMATIC was First" to design and build a Heavy Duty Motorized Conveyor platform Lift Truck for quick and efficient distribution of sheet steel loads to and from conveyor ends in finishing departments.



Reviewing this record you can readily understand why so many Steel Men have placed their confidence in the ability of "AUTOMATIC". Such confidence must be merited. We believe the hundreds of successful "AUTOMATIC" installations in the steel industry and the continually increasing purchases of such "AUTOMATIC" equipment are by far the answer.

So if you have steel handling problems, "Profit by the Record." Write today for an "AUTOMATIC" Steel Representative to discuss the possibility of profitable application of "AUTOMATIC" trucks, tractors or Cranes.

"AUTOMATIC was First" to design and build a basically new Industrial Truck Controller having such outstanding features as:
Absolutely plug proof and fool proof operation.
No quick plowing into high speed or reversing while in speed.
No manual adjustment required mechanically or electrically.
Self-compensating Rotor Brushes, constant tension.
Commutator type extruded segments unit molded in permanent insulated bases.
No voltage load on return to neutral. Built in dynamic brakes.

AUTOMATIC TRANSPORTATION COMPANY
47 WEST 87TH STREET CHICAGO, ILL.

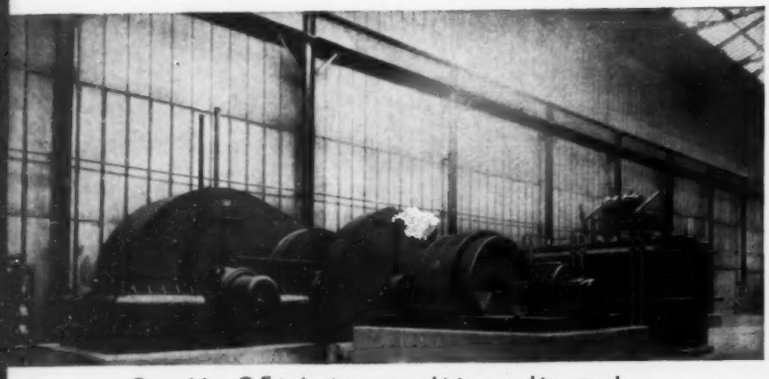
PIONEER MANUFACTURERS OF POWER TRUCKS - TRACTORS & CRANES

WELCOME TO CHICAGO . . . ASSOCIATION OF IRON AND STEEL ENGINEERS . . . AT THE HOTEL STEVENS
SEE AUTOMATIC EXHIBIT . . . LOWER LOBBY . . . BOOTHS 120-121-122-123

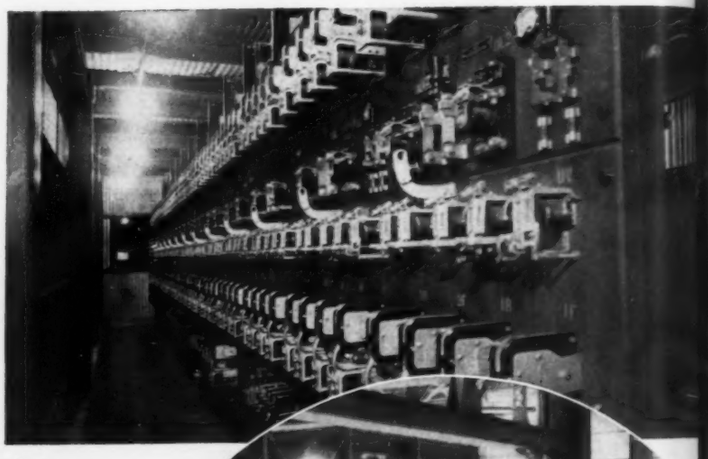
IN ANOTHERL

G-E DEPENDABILITY HELPS KEEP

EQUIPMENT THAT HELPS KEEP OPERATIONS CONTINUOUS IN THE 80-INCH HOT-STRIP MILL

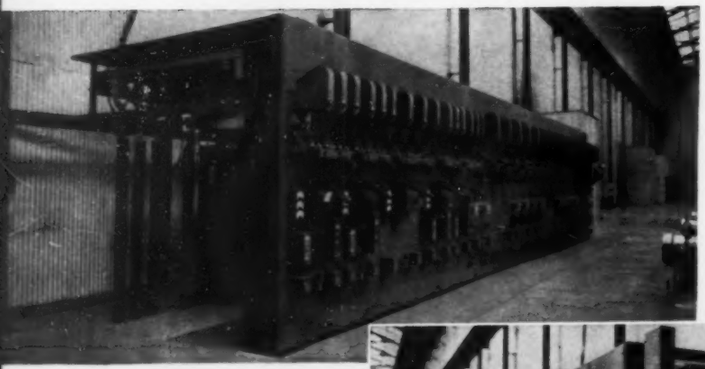


One of five G-E induction motors driving roughing stands

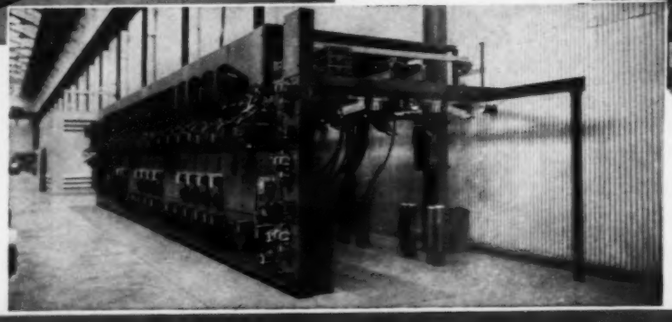


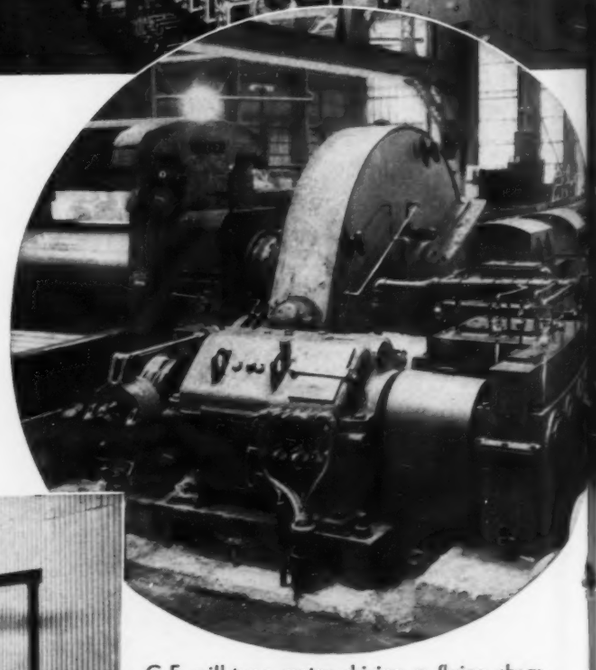
G-E auxiliary control board, consisting of many panels. This board was shipped from the factory completely assembled

SWITCHGEAR



G-E automatic reclosing switchgear used for the most important 250-volt d-c and 440-volt a-c auxiliary service. This switchgear is equipped with heavy-duty circuit breakers and is typical of equipments that have thoroughly proved their ability to "take it"





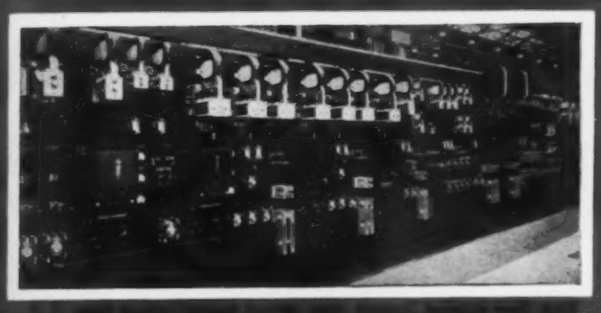
G-E mill-type motor driving a flying shear. This is one of many hundred such motors in service in this plant that drive cranes and auxiliaries of every description

GENERAL

R LEADING PLANT

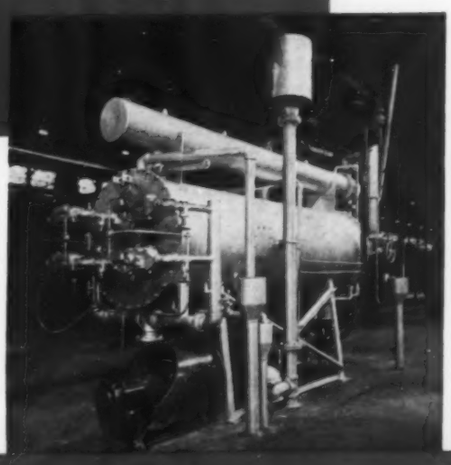
EER PRODUCTION COSTS DOWN

EQUIPMENT THAT PROVIDES BRAINS AND BRAWN IN THE 84-INCH COLD-STRIP MILL



for holding strip under tension between the mill stands. It was

G-E adjustable-speed d-c motors driving the stands in the mill, the highest-powered in operation



ATMOSPHERE CONTROLLERS

G-E atmosphere controllers—18 of them—supply the atmosphere for the annealing furnaces in this plant. Shown here is one of three machines with a capacity of 15,000 cu ft per hour

IN this plant G-E equipment is used in practically every phase of the strip-making process. It is dependable. It helps to assure continuous operation. Thus it is one of the most important factors in keeping production costs down.

Glance over the illustrations on these pages and notice that a nearly complete line of electric equipment for steel-mill service is represented—main-roll motors, switchgear, auxiliary drives, factory-assembled control panels, and atmosphere controllers for annealing furnaces.

This wide range of types carries an important message to steel men everywhere—that General Electric stands ready to design and build all the electric equipment for any mill—equipment that is complete and co-ordinated in all its parts.

The long experience of our engineers assures the successful handling of your plans for any size or type of mill. And whether the job is large or small, they will give it the same complete service and attention to details.

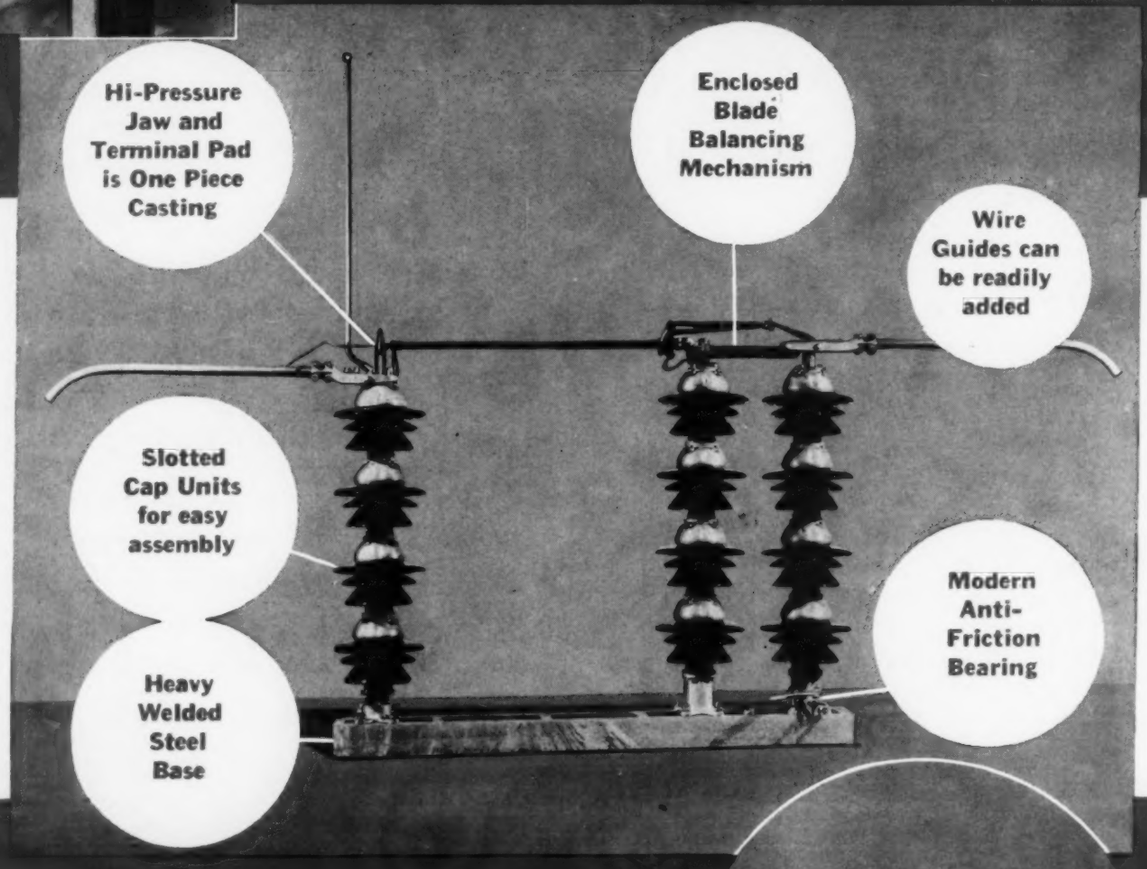
Let G-E engineers help you with your problems. Our nearest representative will be glad to give you further information. General Electric Company, Schenectady, New York.

011-261

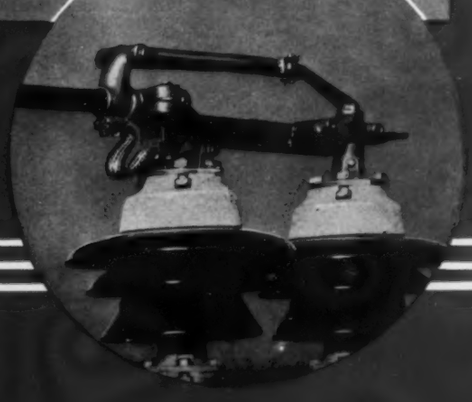
E L E C T R I C

Switches by R&IE.. with the original

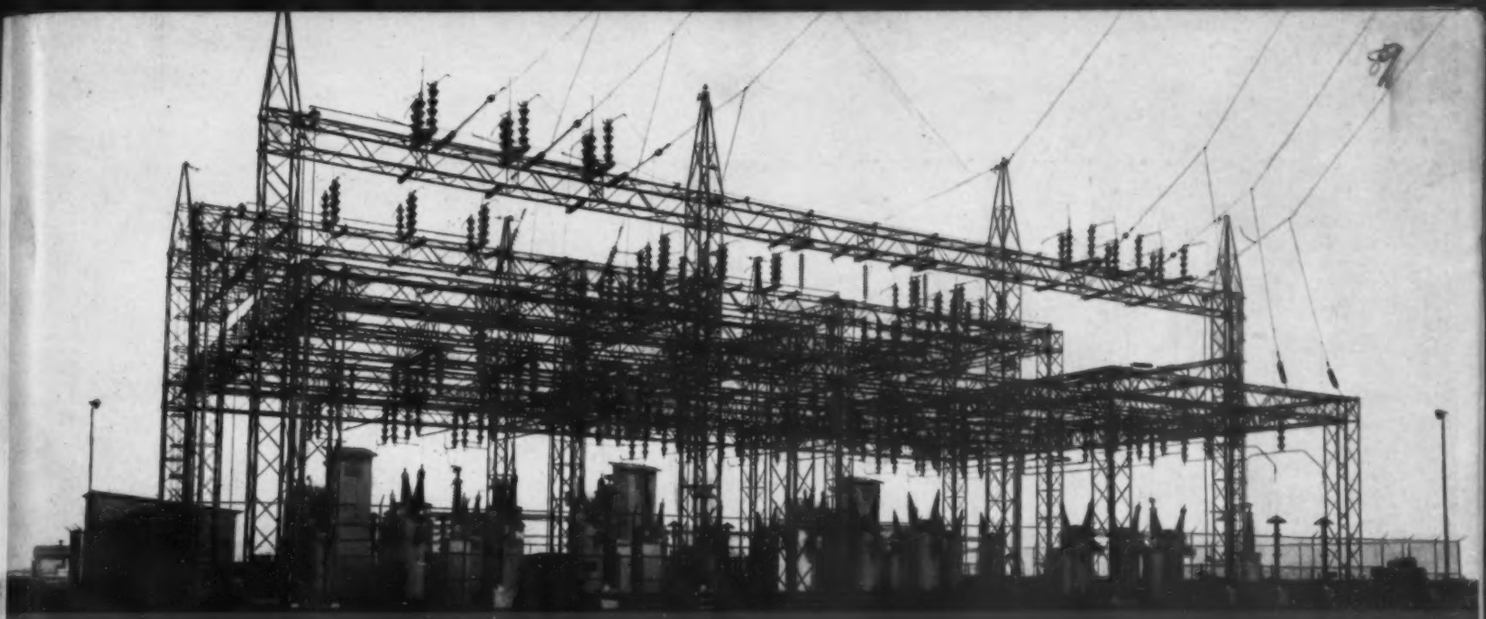
Click there's the proof


Hi-Pressure Jaw and Terminal Pad is One Piece Casting
Enclosed Blade Balancing Mechanism
Wire Guides can be readily added
Slotted Cap Units for easy assembly
Modern Anti-Friction Bearing
Heavy Welded Steel Base

R & IE group switches can be operated with any of several types of control mechanisms-manual or motor operated . Motor operated mechanisms may be remote control or part of a supervisory system.

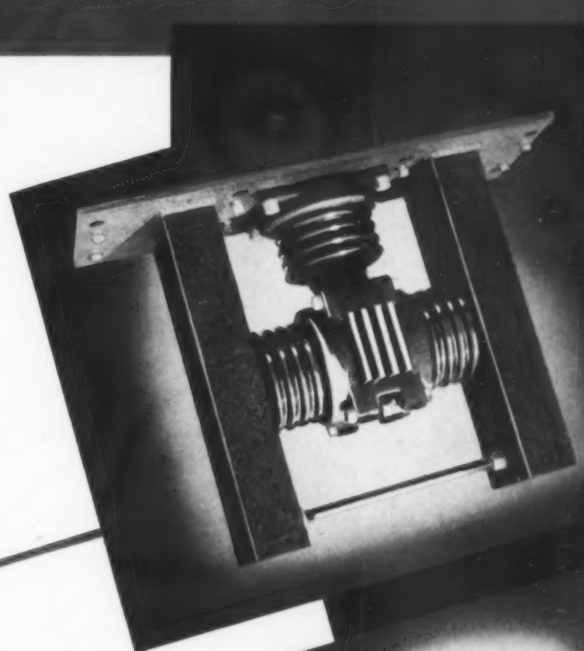


Have the new bulletins? write to . . . . RAILWAY AND INDUSTRIAL GREENSBURG

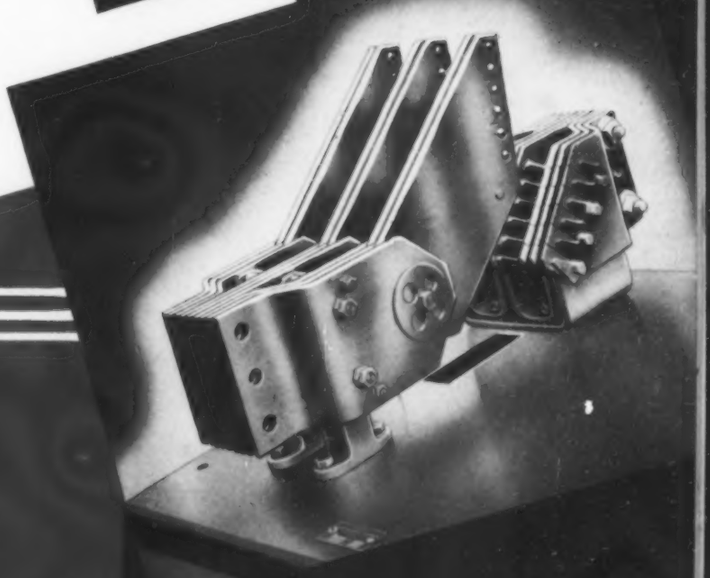


HI-PRESSURE CONTACT

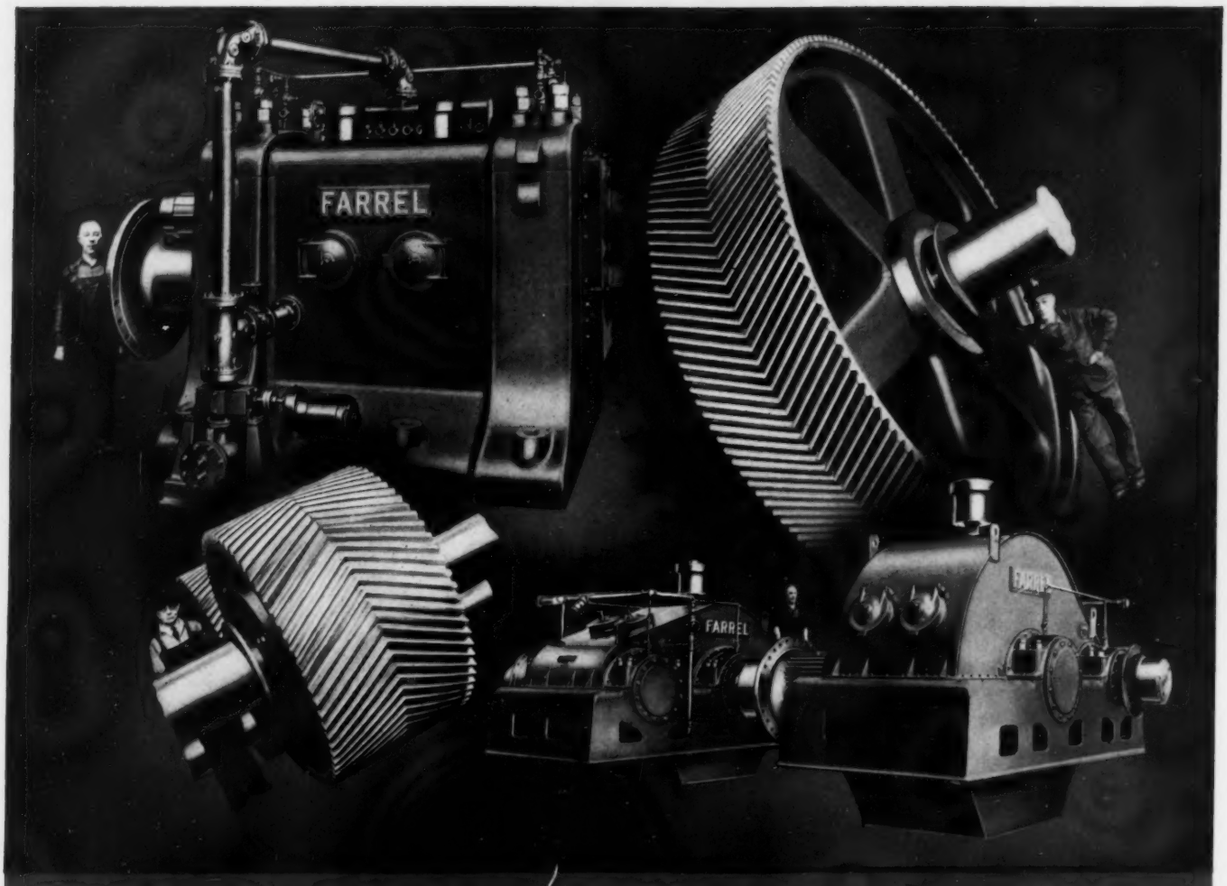
A thousand words cannot better explain and prove the effectiveness of Hi-Pressure contacts than the candid camera proof shown on the opposite page, upper left. This switch contact was closed after standing open for one year and exposed to sulphur smoke, acid fumes, soot, dirt, and all other elements found in the air of a large industrial section. Notice that the contact surface is wiped clean and that there will be an actual metal-to-metal contact. Note the neat streamline appearance and the simplicity of design of the entire switch.



Typical Bus Structures and Switches designed for heavy industrial and steel mill work. Well ventilated, Hi-Pressure Spot Contacts—straight line, terminal-to-terminal flow of current—annular ring pressure hinge contacts—are important switch features. High strength and complete lineup for all requirements feature R&IE bus support equipment.



ENGINEERING COMPANY
PENNSYLVANIA



FARREL-SYKES GEARS and DRIVES for the STEEL MILL

Many tough steel mill jobs have proved the rugged endurance of Farrel-Sykes Gears and Drives and their ability to deliver unfailing performance under the severest operating conditions. They are designed to withstand the stresses, shocks and wear imposed by the heavy loads and high speeds encountered in the modern steel mill.

Farrel-Sykes Gears have the "backbone" for heavy duty service. The continuous herringbone teeth give them extra strength and load carrying capacity, and the accuracy of tooth generation by the famous Sykes process makes them smooth-running, efficient and economical.

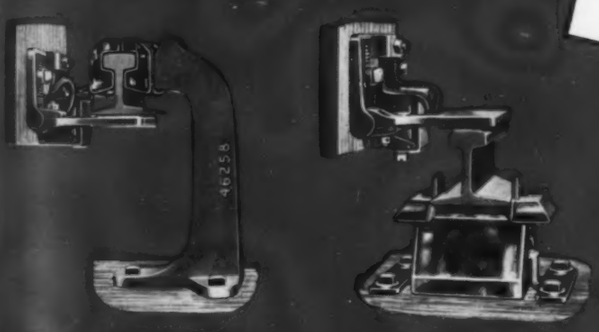
The successful operation of Farrel-Sykes Drives is the result of modern design, modern materials and modern methods of construction, properly combined and applied by engineers and mechanics who have a thorough knowledge of the problems involved. Their extensive experience is available to anyone with a drive problem.

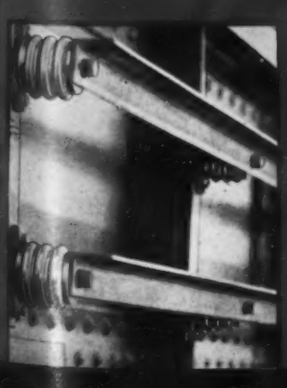
FARREL SYKES GEARS

FARREL-BIRMINGHAM COMPANY, Inc.

ANSONIA, CONN. - - - - - BUFFALO, N. Y.

The Gear with a Backbone





You are cordially invited to inspect these Products in Display Booths 206-207, Hotel Stephens, Chicago

KEYSTONE
ELECTRICAL MATERIAL
for
CRANES & INDUSTRIAL HAULAGE SYSTEMS

If you do not have our Catalog No. 10 and Supplement, please ask for them.

Manufactured by

ELECTRIC SERVICE SUPPLIES CO.

17th and Cambria Streets, Philadelphia

Branches in Principal Cities

APPLETON ELECTRIC PRODUCTS ARE STANDARD FOR FACTORIES

APPLETON UNILETS

Appleton Unilets are standard equipment in thousands of factories because they are properly built for easy installation and long, trouble-free service. Made of rugged malleable iron they resist failure caused by vibration or shock. Coated with cadmium, they combat rust and corrosion. Appleton Unilets are designed in a multitude of shapes to exactly fit every wiring need.

Type "C"—Threaded Rect. Unilet

Type "LL"—No Thread Rect. Unilet

Type "C"—Threaded Form 35 Unilet

Type "LB"—No Thread Form 35 Unilet

Type "EVA" Explosion-Proof Lighting Fixture (100 and 200 Watt)

Type "CEST" Explosion-Proof Receptacle Equipment Complete with Type "CPH" plug

MDS Series Explosion-Proof Unilets

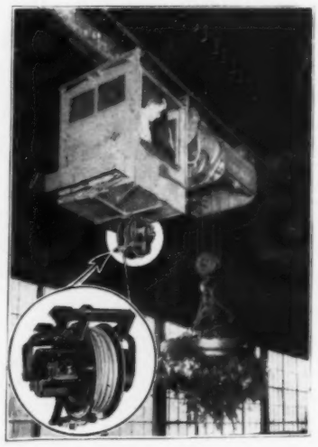
Constant Duty

Reelite

Reg. U. S. Pat. Off.

Automatic Take-up Reels

Appleton Constant-Duty Reelites efficiently tend all types of cables—increasing their span of usefulness and cutting down costly waiting time caused by cable breakdowns.



Type "CPSIC" Unilet Complete with Lift Cover (Closed)

Type "EFSC" Motor Control Push Button Station

PORTABLE

Reelite

Reg. U. S. Pat. Off.

The Handy Light on a Reel

Appleton Portable Reelites improve workmen's efficiency in many factories by spotting light exactly where it is needed. The reel eliminates wear and tear on the cord by constantly rewinding it out of the way.

APPLETON EXPLOSION-PROOF UNILETS

Appleton Explosion-Proof Unilets are designed for the specific purpose of eliminating the hazard of electrical detonation of gas or dust. They meet the rigid specifications of the Underwriters' Laboratories. In use they protect lives of workmen and *reduce insurance costs.*

WRITE TODAY FOR COMPLETE INFORMATION ON ALL APPLETON PRODUCTS

Sold Through Wholesalers

APPLETON ELECTRIC COMPANY

1717 WELLINGTON AVENUE • CHICAGO, U. S. A.

NEW YORK—76 Ninth Avenue
SAN FRANCISCO—655 Minna Street

LOS ANGELES—340 Azusa Street
DETROIT—7310 Woodward Ave.

ST. LOUIS—420 Frisco Building
ATLANTA—203 Luckie St., N.W.

Dings *Again* at the World's Largest Steel Plant

With production schedules stepped up as they are today, especially for the continuous strip and plate mills, there can be no time for expensive shutdowns due to faulty clutches. When your roller changes gauge settings on his mills, he wants to be sure that both screw-downs are coming down together. If they fail to do that very thing, the next strip rolled is going to be scrap.

Grease is prevalent everywhere in the mills and if it can get to the face of the "tie-in" clutch, there is bound to be trouble due to slippage. The Dings Magnetic Clutch faces are well protected from grease by means of a specially designed grease deflector which will allow no grease to throw off from the pilot bearing by centrifugal force, nor allow any drippings to get past when the clutch is not in motion.

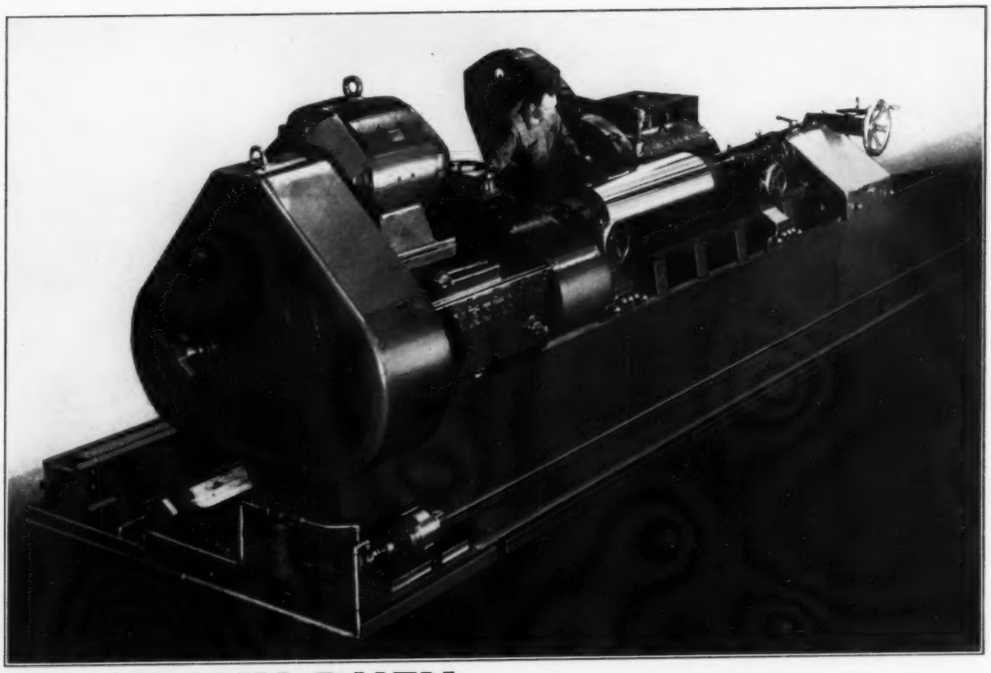
Dings equipment is proved equipment — proved in service since 1899. It is significant that such firms as Carnegie-Illinois are using them.

The next time you are faced with a clutch problem, call a Dings Engineer. There is no obligation and he can help you.

Dings High Intensity MAGNETIC CLUTCHES

DINGS MAGNETIC SEPARATOR CO., 662 Smith St., Milwaukee, Wis.

Yes- PRECISION PAYS!



IN HEAVY-DUTY STEEL MILL EQUIPMENT

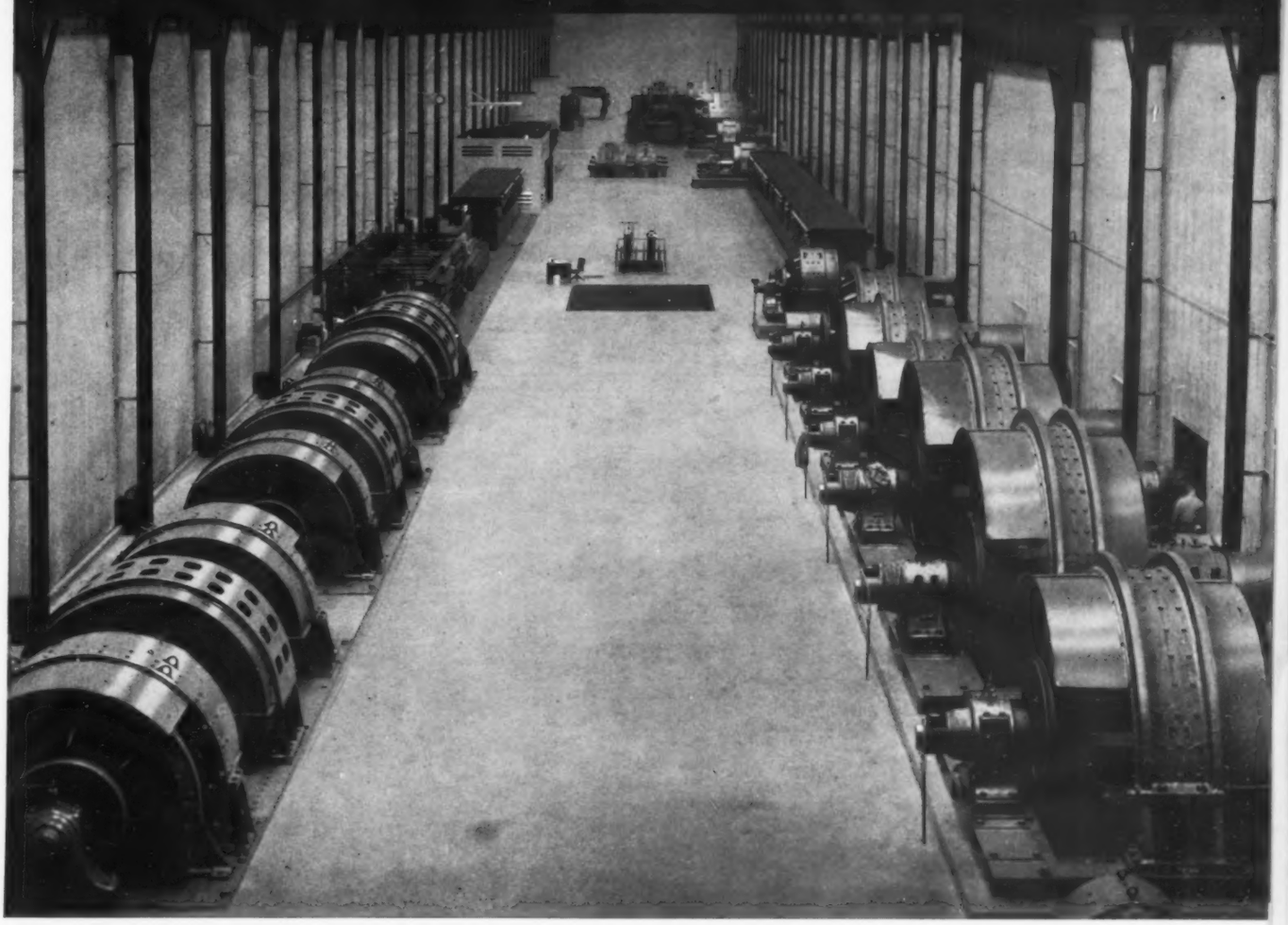
The NORMA-HOFFMANN line includes 108 distinct series, embracing over 3000 catalogued sizes—a PRECISION BEARING for every load, speed and duty. Write for the Catalog. Let our engineers work with you.

So Mesta Machine Company of Pittsburgh, Pa., employed NORMA-HOFFMANN PRECISION BEARINGS in the headstock of the 42-inch Roll Grinder here pictured—which is a part of an 80-inch Continuous Hot Strip Mill. * * * * For all heavy-duty service, engineers, designers and builders find that NORMA-HOFFMAN PRECISION stands for all the qualities which make for longer life, lower costs, better performance, and greater freedom from shut-down losses.

"NORMA-HOFFMANN"
PRECISION BEARINGS
BALL, ROLLER AND THRUST

NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONN., U.S.A.

Uninterrupted Production



HOT STRIP MILL MOTOR ROOM ALLIS-CHALMERS FINISHING MILL MOTOR MAIN MOTOR GENERATOR SETS AND CONTROL

Today's demand is for wider strip, and larger plates. Machinery to produce these must be constantly improved . . . made heavier and larger. Allis-Chalmers main roll drives have an excellent record in giving reliable, continuous service in supplying power for these new mills.

The hot strip mill, illustrated above, is powered by six 4500 hp Allis-Chalmers d-c motors supported by three 6000 kw three-machine motor-generator sets, all controlled through an Allis-Chalmers switchboard.

Allis-Chalmers d-c motors have armatures 100% cross-connected without the use of separate cross connectors. Commutators are specially designed for steel mill service; special field structure, superior insulation, rigid rolled steel yokes, large forged steel shafts, large heavy-duty bearings and heavy steel bases, all contribute to a high standard of reliability.

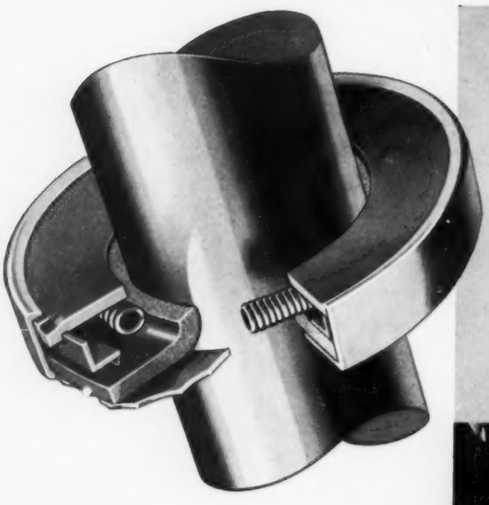
Synchronous and wound rotor motors, motor-generator sets, mercury arc power rectifiers, switchboards, control, metal-clad switchgear, power generating units, auxiliary motors, blowers, compressors, and many other Allis-Chalmers products are built to meet the exacting requirements of continuous steel mill service. Allis-Chalmers engineers have had broad experience in steel mill problems. Call upon them when considering new mills or modernization of old ones.

804

ELECTRICAL DIVISION

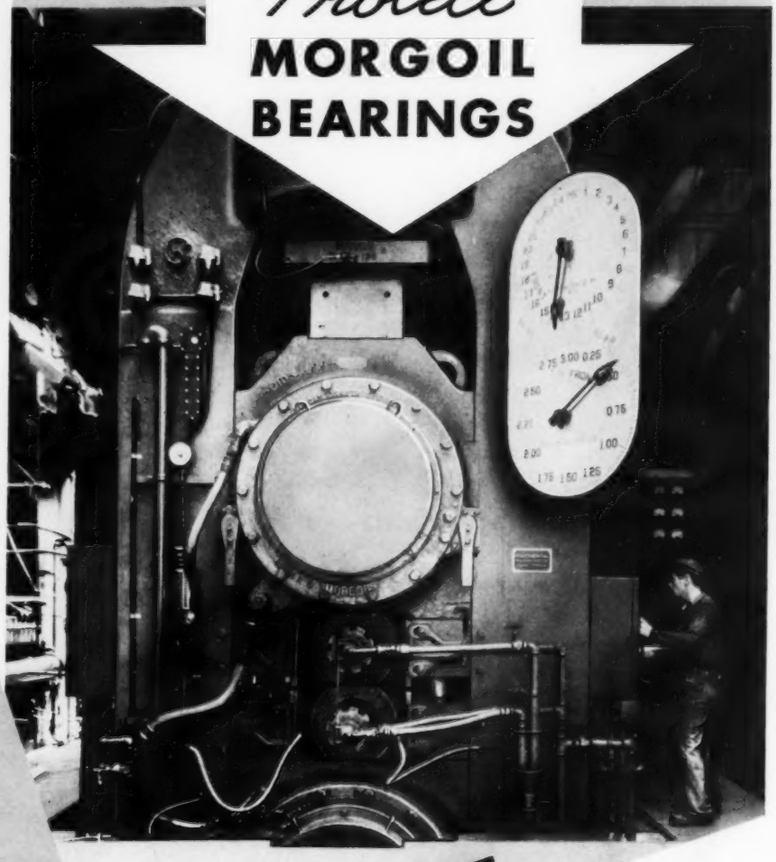
ALLIS·CHALMERS

MILWAUKEE WISCONSIN



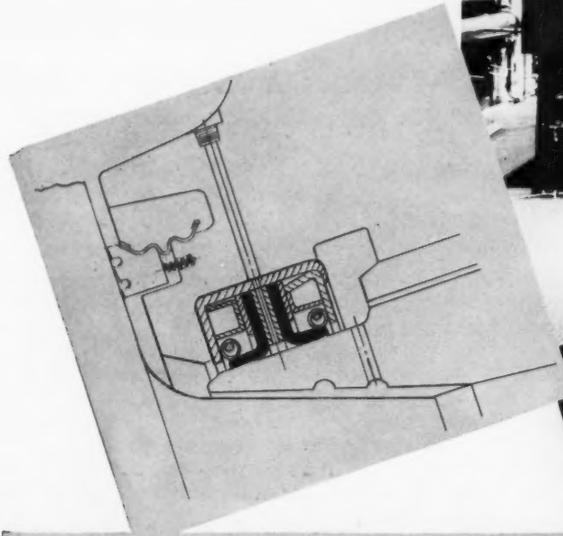
"Perfect" OIL SEALS

Protect MORGOIL BEARINGS



Morgan Construction Company Engineers, recognizing the importance of proper exclusion of foreign matter as well as constant, dependable oil retention, have for years specified Chicago Rawhide "Perfect" Oil Seals of various types for the highly individualized applications on which their bearings function.

If you have a critical sealing problem, ask Chicago Rawhide engineers for their suggestions in handling it.



PERFECT *Oil Retainer* PATENTED

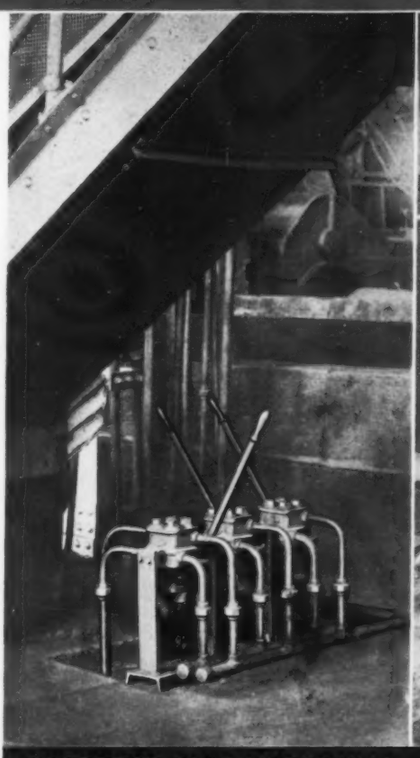
CHICAGO RAWHIDE MANUFACTURING COMPANY

1307 ELSTON AVENUE • CHICAGO, ILLINOIS

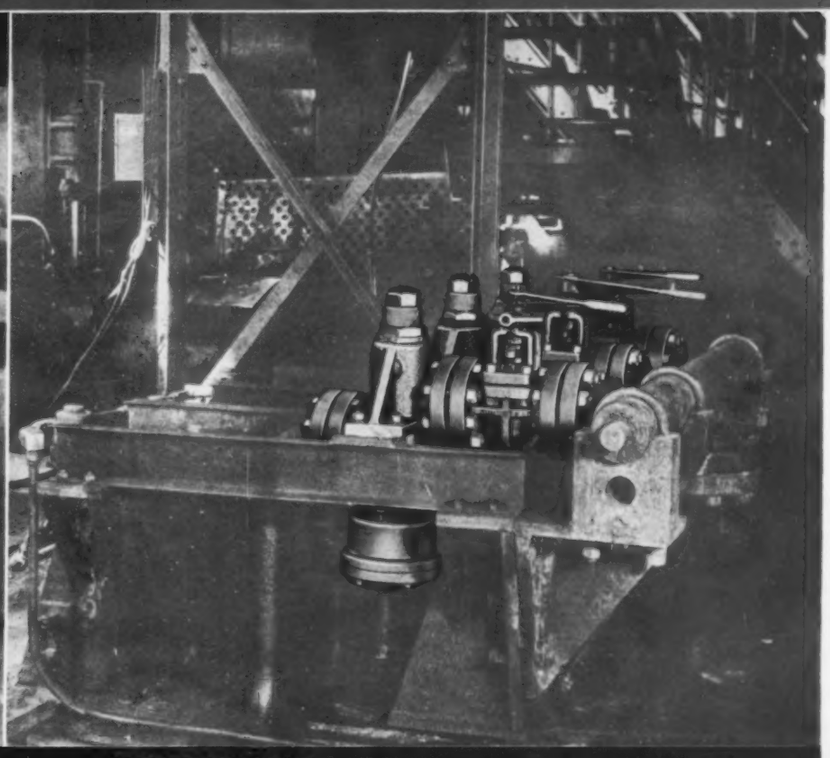
59 Years Manufacturing Quality Mechanical Leather Goods Exclusively

PHILADELPHIA CLEVELAND NEW YORK DETROIT BOSTON PITTSBURGH CINCINNATI

STEEL PLANTS REDUCE OPERATING COSTS BY USING THESE HOMESTEAD VALVES



PROTECTED SEAT HYDRAULIC OPERATING VALVES



PROTECTED SEAT SPRAY VALVES

LIFT-PLUG VALVES

Homestead, the ONLY hydraulic operating valve with B & O Patented Protected Seat, gives:

(1) Lowest operating costs.

(2) Positive control.

(3) Ease of operation.

(4) Freedom from water-hammer.

on the control of manipulators, furnace doors, soaking pit covers, shears, presses, ingot strippers, roll balance, loopers, dampers, etc.

The Pioneer Descaling Valve affords:

(1) B & O patented Protected Seat.

(2) A principle proved by more than 2000 installations.

(3) Positive patented shock elimination.

(4) Phenomenally low maintenance.

(5) Extremely low pressure drop.

(6) Ease of operation.

Homestead Lift-Plug Valves assure positive dependable operation under severe conditions.

(1) They cannot stick — positive mechanical unseating.
(2) Positive mechanical seating makes drop-tight seal.
(3) Quick operation — quarter-turn to open or close.
(4) Long valve life — seating surfaces protected in open and closed positions.
(5) Minimum friction loss.
(6) Require no attention.
(7) Require no lubrication.

Write for Reference Book No. 37. Consult our engineers on your special valve problems.

HOMESTEAD VALVE MANUFACTURING CO., Coraopolis, Pa.

HOMESTEAD VALVES

QUARTER-TURN VALVES:
STRAIGHT-WAY
THREE-WAY
FOUR-WAY
LUBRICATED TYPE
LIFT-TYPE PLUG

PROTECTED SEAT VALVES:
HYDRAULIC (B & O PAT.) OPERATING
REMOTE CONTROL
HYDRAULIC DESCALING
ROSS AIR SHUT-OFF VALVES
HOVALCO BLOW-OFF VALVES

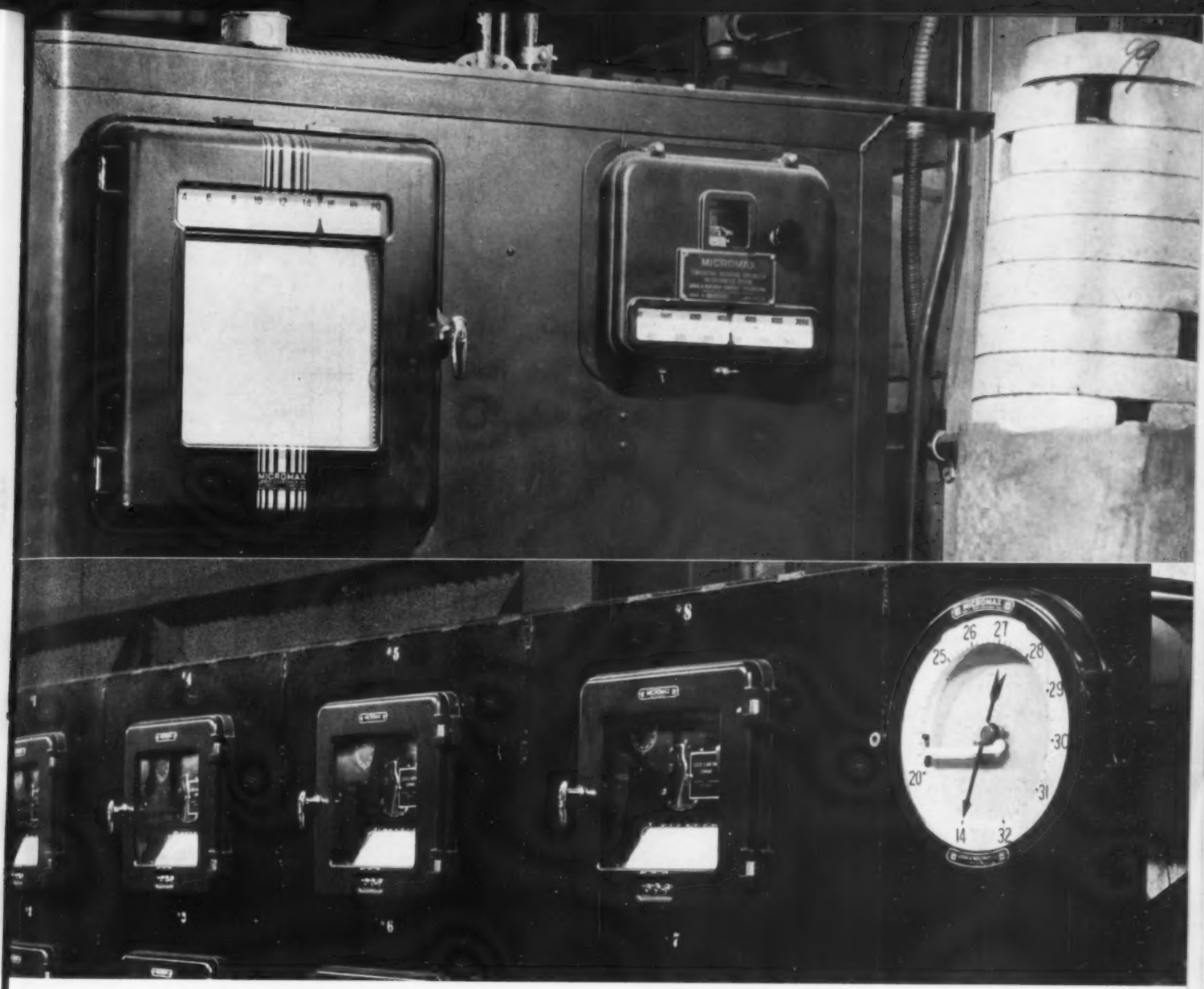
Battery of Swindell Furnaces in large midwestern Strip Mill

SWINDELL

Recirculating Radiator Type Furnaces

SWINDELL-DRESSLER CORPORATION

PITTSBURGH, PA.



Micromax Pyrometers . . . in steel mills

AS *Steel Men* LIKE THEM . . .

MICROMAX FAMILY PRESENTS TEMPERATURES

A choice among Micromax pyrometer models—each offering a distinct way of presenting temperature facts that are fully dependable—enables steel-mill men to make Micromax the mills' standard for all pyrometer applications.

For extreme visibility, there's the Round-Chart Model R. For highly-detailed records from any number of couples, plus a bold index, there's the Silver-Anniversary Strip-Chart Model S. And if no record is needed, there is the Indicating Controller, Model C. Not shown are the Non-Indicating Controller, the Optical Pyrometer, the Speedomax High-Speed Recorder, and various Portable Indicators, which make the L&N line entirely unique in its completeness. Catalogs on request.

See Micromax and other L&N Instruments at the Iron & Steel Show

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

J-N33-0660(1)

FARVAL *on* 16,000 BEARINGS

in one continuous strip mill . . .

• Eleven additional continuous hot strip mills are also completely equipped with Farval. More than 60 cold mills are similarly equipped, giving a total of more than 250 strip mill stands whose lubrication is assured by the dependable performance of a Farval Centralized System of Lubrication.

In each of these installations, Farval delivers an exact, measured charge of grease, at high pressure to every bearing. There is never a feast nor a famine, because every bearing always receives the proper amount of lubricant. The frequency may be varied to suit the conditions, but the performance is constant and positive.

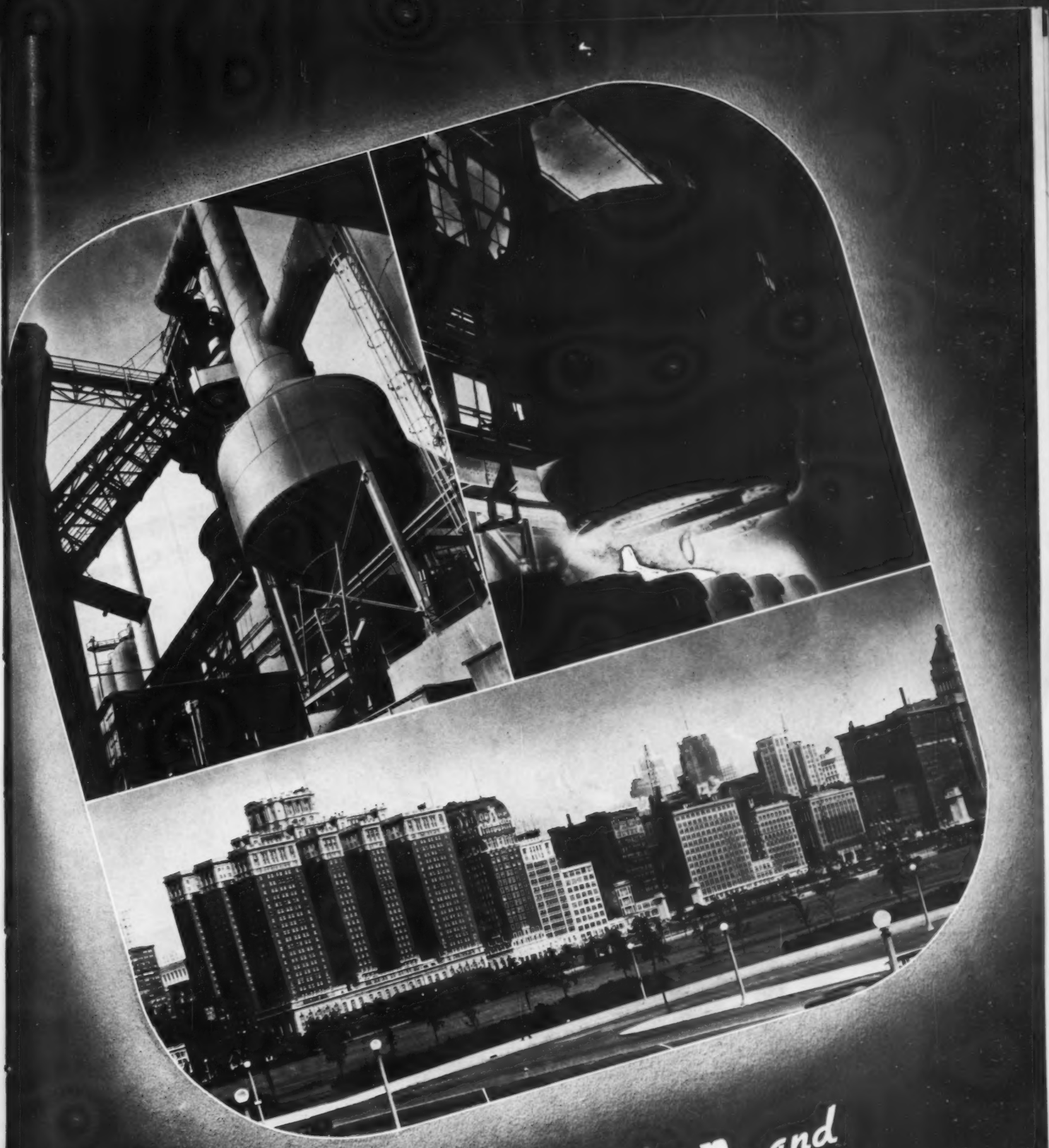
Farval lubricated bearings are thus protected in advance against costly delays and the expense of replacement.

The Farval Corporation, 3278 East 80th Street, Cleveland, Ohio.

Affiliate of The Cleveland Worm & Gear Co., Cleveland, Manufacturers of Automotive and Industrial Worm Gearing.

FARVAL

CENTRALIZED SYSTEMS OF LUBRICATION



33rd convention and IRON & STEEL EXPOSITION

HOTEL STEVENS, CHICAGO, ILL.

SEPTEMBER 28, 29, 30 AND

OCTOBER 1, 1937

H. G. R. Bennett

PRESIDENT

A. I. & S. E.

IT is with great pleasure that I extend a cordial welcome to all our members and others in the steel industry to attend our Annual Convention and Exposition to be held in the Stevens Hotel, September 28, 29, 30 and October 1. With the aid of the various committee men mentioned in the following pages, a very interesting program has been arranged which should be helpful to all of us in our everyday work. I am looking forward to one of our most successful meetings as well as with the anticipation of greeting many new and old faces at our Annual Convention.

CONVENTION COMMITTEES

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H. G. R. Bennett, Chairman
J. L. Miller, Vice Chairman

GENERAL CONVENTION COMMITTEE

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Wilfred Sykes	George E. Rose	J. H. VanCampen	E. W. Trexler	W. Guy Hoffman
J. S. Murray	H. G. Gibson		Wm. Jackson	L. A. Terry

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L. W. Long	W. A. James	W. S. Riggs	G. A. Kauffman	L. Dahl

COMMITTEE ON ATTENDANCE

H. W. Neblett, Chairman
Fred O. Schnure, Vice Chairman

John L. Young	A. J. Boynton	J. M. Kelly	W. E. Blythe	F. H. Barnard
J. W. Corey	W. W. Powell	R. L. Wolter	J. Duff Reed	P. M. Offill
A. A. Van Pelt	V. A. Menaglia	R. R. Dallye	E. F. Carey	W. J. Ramsey
J. K. Keogh	H. D. Rei	J. S. Smith	D. J. Richards	M. J. Bradley
A. J. Jennings	A. E. Krogh	H. E. Ewart	G. R. Horne	H. A. Fennerty
H. H. Wood	A. S. McCloy	J. P. Flippen	H. J. Hall	R. M. Currie
J. R. Lewis	H. D. Robb	E. A. Harper	J. R. Seaman	J. Green
E. S. Glauch	H. J. Fisher	R. G. Widdows	V. J. Nolan	J. R. Patterson
J. J. Heuther	W. R. Duda	J. Guy Griffith	G. E. Stoltz	C. E. Powell

EXHIBITORS INFORMAL DANCE COMMITTEE

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F. A. Wiley, Vice Chairman

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B. J. Ballard	O. Schauer	F. J. Burd	T. D. MacLafferty	A. J. Dreyer
J. K. Mahaffey	R. W. Leech	M. J. Van Leeuwen	H. S. Richardson	F. C. Lamar
C. E. Bedell	A. E. Balke	W. A. Lintern	F. W. Vogt	E. W. Weiss
A. M. Ramsey	W. H. Williams	H. E. Slack	A. C. Dyer	H. J. Saladin
R. E. Brown	W. H. Boyce		Jos. Kinney, Jr.	L. T. Barry

FORMAL RECEPTION COMMITTEE

H. G. R. Bennett, Chairman

L. F. Coffin	J. D. Donovan	H. G. Hague	M. J. Conway	R. G. Adair
C. C. Wales	F. D. Egan	A. C. Cummins	W. S. Hall	F. E. Leahy
F. E. Flynn	F. W. Cramer	D. M. Petty	A. J. Standing	F. O. Schnure
W. A. Perry	J. C. Reed	C. L. McGranahan	Jas. Farrington	J. A. Clauss
C. C. Pecu	W. H. Burr	E. Friedlander	G. R. Carroll	O. R. Jones
	J. W. Bates		J. L. Miller	

OFFICIAL PROGRAM

33RD ANNUAL CONVENTION AND IRON AND STEEL EXPOSITION

CHICAGO, ILLINOIS

STEVENS HOTEL

SEPTEMBER 28, 29, 30, AND OCTOBER 1, 1937

TUESDAY, SEPTEMBER 28, 1937

9:00 A.M. Third Floor.

Registration

CHAIRMAN	VICE CHAIRMAN
H. G. HAGUE, Electrical Superintendent Sheet and Tin Plate Division Carnegie-Illinois Steel Corp. Gary, Indiana	WALTER H. BURR, Electrical Superintendent Lukens Steel Company Coatesville, Pennsylvania

BUSINESS SESSION

North Ball Room, Third Floor

CHAIRMAN	VICE CHAIRMAN
H. G. R. BENNETT Assistant General Superintendent Carnegie-Illinois Steel Corp. Duquesne, Pennsylvania	J. L. MILLER Assistant Combustion Engineer Republic Steel Corporation Cleveland, Ohio

9:15 A.M.

Annual Meeting and Business Session of Association of Iron and Steel Engineers.

9:30 A.M.

TECHNICAL SESSION

CHAIRMAN	VICE CHAIRMAN
F. D. EGAN, Electrical Superintendent Bethlehem Steel Company Lackawanna, New York.	WILLIAM A. PERRY, Supt. of Elec. and Power Depts., Inland Steel Company Indiana Harbor, Indiana.

"THE TESTING DEPARTMENT OF A LARGE STEEL COMPANY" by Birger Thele, Test Engineer, Tennessee Coal, Iron and Railroad Company, Fairfield, Alabama.

"LAYOUT AND INSTALLATION OF LOW VOLTAGE D. C. AND A. C. SYSTEMS IN STEEL PLANTS" by Donald Nelson, Assistant Electrical Engineer, Jones & Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

"SURGES AND THEIR EFFECT ON TRANSFORMERS" by H. Weichsel, Consulting Engineer, Wagner Electric Corporation, St. Louis, Missouri.

Combustion Engineering Division

South Ball Room, Third Floor

9:30 A.M.

CHAIRMAN	VICE CHAIRMAN
A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland.	T. J. ESS, Combustion Engineer, Republic Steel Corporation, Massillon, Ohio.

"PROTECTIVE ATMOSPHERE FOR ANNEALING FURNACES IN STEEL MILLS" by A. N. Otis, General Electric Company, Schenectady, New York.

"COMPLETE CONTROL OF RECUPERATIVE AND REGENERATIVE SOAKING PITS" by A. E. Krogh, Market Development Department, Brown Instrument Company, Philadelphia, Pennsylvania.

Boulevard Room

12:15 P.M.

Welcome Luncheon

TUESDAY, SEPTEMBER 28, 1937

North Ball Room

2:00 P.M.

Combustion Engineering Division

CHAIRMAN	VICE CHAIRMAN
W. S. HALL, Chief Engineer, Chicago District, Carnegie-Illinois Steel Corp. Chicago, Illinois.	FRANK E. LEAHY, Combustion Engineer, Youngstown Sheet & Tube Company Youngstown, Ohio.

"STEAM POWER DEVELOPMENTS" by Charles W. E. Clarke, Consulting Engineer, United Engineers and Constructors, Inc., Philadelphia, Pennsylvania.

"DESIGN AND OPERATION OF NEW BOILER HOUSE—OHIO WORKS, CARNEGIE-ILLINOIS STEEL CORPORATION" by C. H. Williams, Assistant Chief Engineer, Carnegie-Illinois Steel Corporation, Youngstown, Ohio.

"THE DEVELOPMENT OF STEAM GENERATION FROM GAS ENGINE EXHAUST IN AMERICA" by T. A. Lewis, Combustion Engineer, Bethlehem Steel Company, Bethlehem, Pennsylvania.

North Assembly Room, Fourth Floor

2:00 P.M.—5:00 P.M.

LADIES CARD PARTY AND TEA

Boulevard Room, Second Floor

10:00 P.M.

Exhibitors Dance, Informal

WEDNESDAY, SEPTEMBER 29, 1937

North Ball Room, Third Floor

9:00 A.M.

CHAIRMAN
G. R. CARROLL,
Electrical Superintendent,
Jones & Laughlin Steel Corp.
Aliquippa, Pennsylvania.

VICE CHAIRMAN
A. W. STEED,
Superintendent of Maintenance,
American Rolling Mill Company,
Middletown, Ohio.

"ORGANIZATION AND FUNCTIONS OF A STEEL PLANT MAINTENANCE DEPARTMENT" by T. E. Hughes, Superintendent of Maintenance, and J. J. Booth, Assistant Superintendent of Maintenance, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania.

"FACTORS INFLUENCING THE SELECTION OF INSULATED CABLES FOR STEEL MILLS" by F. L. Aime, Electrical Engineer; S. J. Rosch, Manager Insulated Products Development and R. B. Steinmetz, District Engineer of the Anaconda Wire and Cable Company, Hastings-on-Hudson, New York.

Lubrication Engineering Division

South Ball Room, Third Floor

9:00 A.M.

CHAIRMAN
C. C. PECU,
Lubrication Engineer,
Bethlehem Steel Company,
Lackawanna, New York.

VICE CHAIRMAN
F. L. GRAY,
Lubrication Engineer,
Carnegie-Illinois Steel Corp.
Gary, Indiana.

"REASONS GOVERNING THE USE OF E. P. LUBRICANTS—APPLICATIONS AND METHODS OF USE" by Ralph C. Walters, Penola, Inc., Chicago, Illinois.

"LUBRICATION OF MORGOIL ROLL NECK BEARINGS" by H. H. Wood, Engineer, Morgan Construction Company, Pittsburgh, Penna.

"STEEL MILL LUBRICATION AND LUBRICANTS FOR ANTI-FRICTION BEARINGS" by O. L. Maag, Timken Roller Bearing Company, Canton, Ohio.

12:30 P.M.

Inspection Trip to Gary Sheet and Tin Plate Division, Carnegie-Illinois Steel Corporation, Gary, Indiana.

1:30 P.M.

Ladies City Sight-Seeing Trip

THURSDAY, SEPTEMBER 30, 1937

North Ball Room, Third Floor

9:00 A.M.

CHAIRMAN
C. L. MCGRANAHAN, Assistant
General Superintendent,
Jones & Laughlin Steel Corp.
Pittsburgh, Pennsylvania.

VICE CHAIRMAN
JAMES FARRINGTON,
Electrical Superintendent,
Wheeling Steel Corporation,
Steubenville, Ohio.

"D. C. DRIVES FOR MILL RUN OUT TABLES AND COILERS" by L. A. Umansky, General Electric Company, Schenectady, New York.

"CORROSION PROOF TANK LININGS" by L. C. Werking, National Carbon Company, Cleveland, Ohio.

"ELECTROLYTIC CLEANING LINES FOR REMOVAL OF OIL FROM STRIP STEEL" by M. Stone, Engineer, Development, United Engineering and Foundry Company, Pittsburgh, Pennsylvania.

"THE FUTURE POSSIBILITIES OF PRODUCING VARIOUS STRUCTURAL SHAPES BY THE COLD ROLL FORMING OF STRIP STEEL" by Howard W. Kane, Kane & Roach, Inc., Syracuse, New York.

Welding Engineering Division

South Ball Room, Third Floor

9:00 A.M.

CHAIRMAN
G. A. HUGHES,
Chief Electrical Engineer,
Truscon Steel Company
Youngstown, Ohio.

VICE CHAIRMAN
WRAY DUDLEY,
Electrical Superintendent,
National Tube Company
McKeesport, Pennsylvania.

"PROGRESS OF WELDING IN 1936 AND 1937" by G. A. Hughes, Chief Electrical Engineer, Truscon Steel Company, Youngstown, Ohio.

"WELDING ECONOMICS AND APPLICATION" by E. W. P. Smith, Consulting Engineer, Lincoln Electric Company, Cleveland, Ohio.

"THE DEVELOPMENT AND APPLICATION OF COVERED ELECTRODE ARC WELDING" by A. M. Candy, Consulting Engineer, Hollup Corporation, Chicago, Illinois.

"ALTERNATING CURRENT ARC WELDING ADVANCE" by C. J. Holslag, Electric Arc Cutting and Welding Company, Newark, New Jersey.

MOTION PICTURES by Clyde Bassler, Taylor Winfield Corporation, Warren, Ohio.

THURSDAY, SEPTEMBER 30, 1937

North Ball Room, Third Floor

1:30 P.M.

CHAIRMAN
FRANK E. FLYNN, General
Manager, Warren District,
Republic Steel Corporation,
Warren, Ohio.

VICE CHAIRMAN
JULIUS A. CLAUSS,
Chief Engineer,
Great Lakes Steel Corporation,
Ecorse, Michigan.

"THE MANUFACTURE AND USE OF IRON AND STEEL ROLLS" by Walter H. White, General Superintendent and F. L. MacQuarrie, Chief Engineer, Pittsburgh Rolls Corporation.

"NOTES ON BLAST FURNACE DESIGN AND PRACTICE" by A. J. Boynton, Vice-President, H. A. Brassert & Company, Chicago, Illinois.

"DEVELOPMENTS IN ROLLING FLAT STEEL PRODUCTS DURING 1937" by Stephen Badlam, Consulting Engineer, Pittsburgh, Penna.

Boulevard Room, Second Floor

6:30 P.M.

Banquet and Dance

The program of the Banquet is arranged to commemorate the 25th Anniversary of the founding of the National Safety Council. This national movement was sponsored by the Association and the formation of the original optional committee was the result of a resolution adopted by the Association at the Annual Convention held in Milwaukee September 30, 1912. Several nationally prominent speakers are included in the program.

FRIDAY, OCTOBER 1, 1937

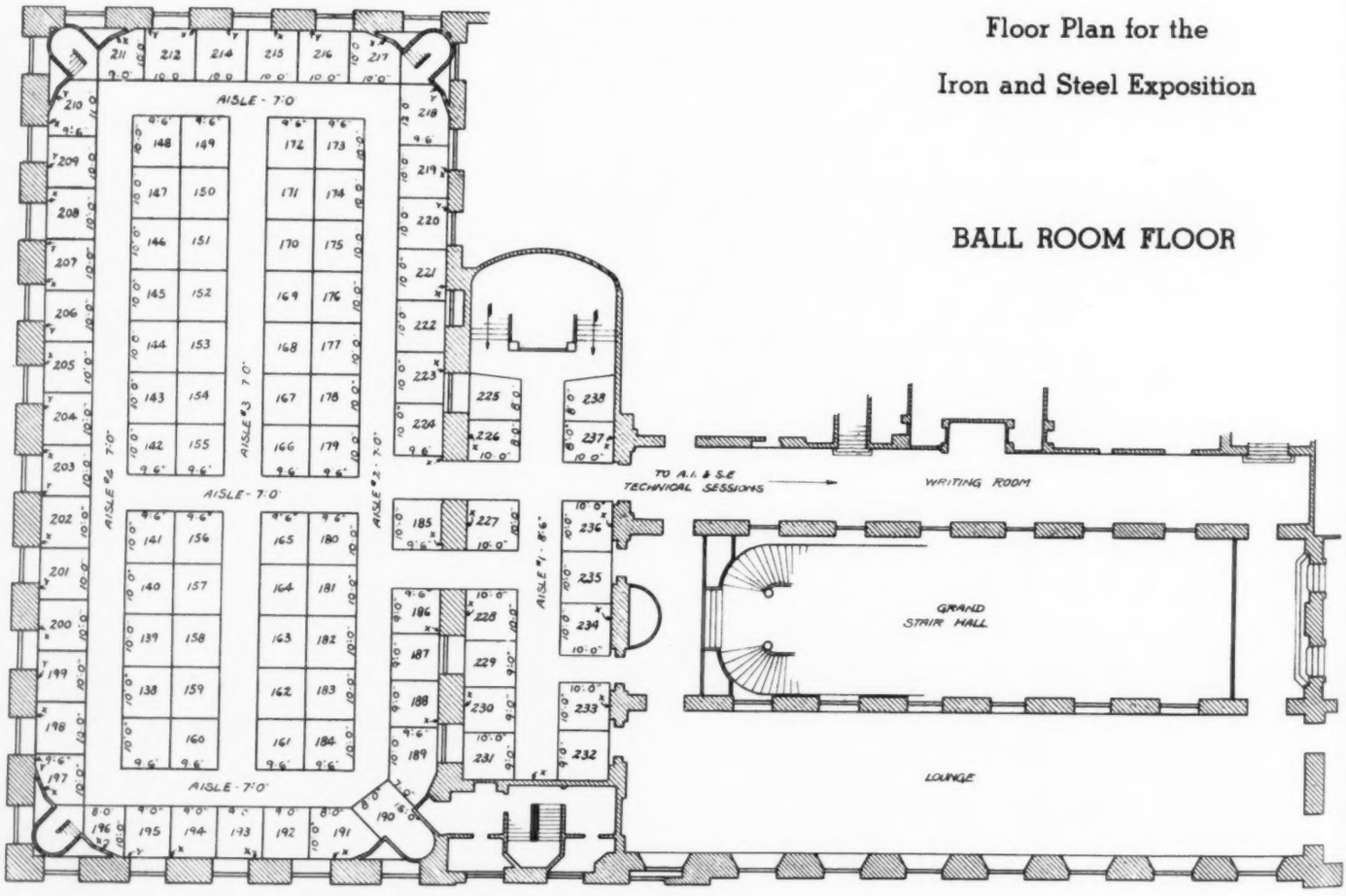
9:00 A.M.

Inspection Trip to Hot and Cold Strip Mills, Inland Steel Company, Indiana Harbor, Indiana.

. . . Be Sure to Visit the Ir

The Iron and Steel Exposition will be one of unusual interest to the engineers and operating executives of the steel industry. Approximately, one hundred and thirty five manufacturers of steel mill equipment are cooperating with the Association in sponsoring this annual show. The exhibits will be located in the grand ball room of the Stevens Hotel and the lower lobby exhibition hall.

Many companies have made elaborate preparations for installing outstanding decorative and educational exhibits. Many of the exhibits will be in actual operation



Floor Plan for the

Iron and Steel Exposition

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Iron and Steel Exposition

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LOWER
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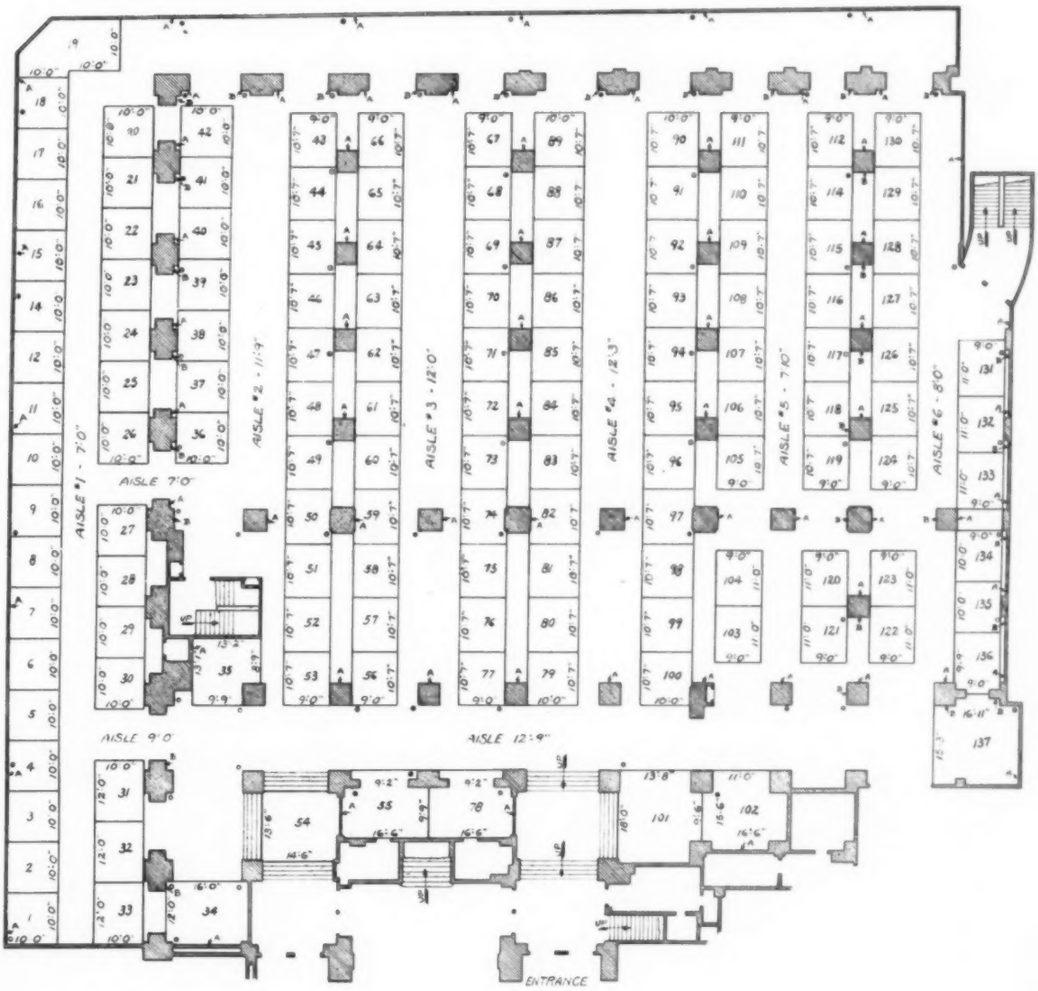
Stev

Iron and Steel Exposition

while others will resort to using miniature models for explaining the many features of their displays. Every visitor to the Convention should budget his time so he will have an opportunity to throughly study all of the exhibits.

Another feature of the Exposition will be the disposition of $500.00 worth of valuable prizes. Only men actively engaged in the steel industry will be eligible for a prize. The first prize will be a model G Leica camera. It will be necessary for everyone to report to the registration desk for the details on how to compete for these prizes.

LOWER LOBBY



Stevens Hotel, Chicago, Ill., Sept. 28 - Oct. 1.

BE SURE TO VISIT THE IRON and STEEL EXPOSITION

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First prize will be this model G Leica, the ultimate in miniature cameras. Briefly, this camera is the most advanced and desirable in the entire camera field and has everything with which to produce the finest of photographs.

▲

Second and third prizes, shown below, are a top grain leather Gladstone bag and a golf bag of excellent quality.

STEEL MEN

win one of the $500.00 worth of prizes which will be awarded at the coming Iron and Steel Exposition, Stevens Hotel, September 28, 29, 30 and October 1. First prize will be a model G Leica camera. Second and third prizes are a traveling bag and a golf bag. There will be ten other prizes valued at $20.00 each. Details on how to win one of these prizes will be furnished at the convention registration desk, Stevens Hotel. Only operating and executive personnel in the industry may compete for these awards.

View of Co
be shown m

CONVENTION INSPECTION TRIPS

Carnegie-Illinois Steel Corp.

Gary Sheet and Tin Division

WEDNESDAY AFTERNOON

SEPTEMBER 29

12:30 P. M.

The inspection trip to the Gary Sheet and Tin Division of the Carnegie-Illinois Steel Corporation, is scheduled for departure at 12:30 P. M. The buses will load and depart from the Michigan Avenue entrance of the Stevens Hotel. The officials of the Carnegie-Illinois Steel Corporation have requested of those who will make the trip, that they use the special transportation facilities, otherwise they will not be permitted to enter the plant.

Tickets will be on sale at the Registration Desk in the Stevens Hotel, beginning Tuesday morning. Price will be $2.00 per person.

View of Cold mill, Carnegie-Illinois Steel Corp., Gary, Ind., to be shown members and guests on Wednesday, September 29, 1937.

View of 76" mill, Inland Steel Company to be inspected by the Association, Friday morning, October 1, 1937.

Inland Steel Company

Indiana Harbor Works

FRIDAY MORNING

OCTOBER 1

9:00 A. M.

The same general plan used in connection with the trip to the Gary Sheet and Tin Division of the Carnegie-Illinois Steel Corporation will be in effect for the inspection trip on Friday morning, to the Indiana Harbor Works of the Inland Steel Company. The buses will leave the Michigan Avenue entrance of the Stevens Hotel at 9:00 A. M. Everyone must use the special transportation facilities.

Tickets will be available at the same source, and the cost will be $2.00 per person.

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WALTER H. BURR
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A. J. BOYNTON
Vice President, H. A. Brassert & Company
Chicago, Illinois

C. L. Mc
Asst. General Su
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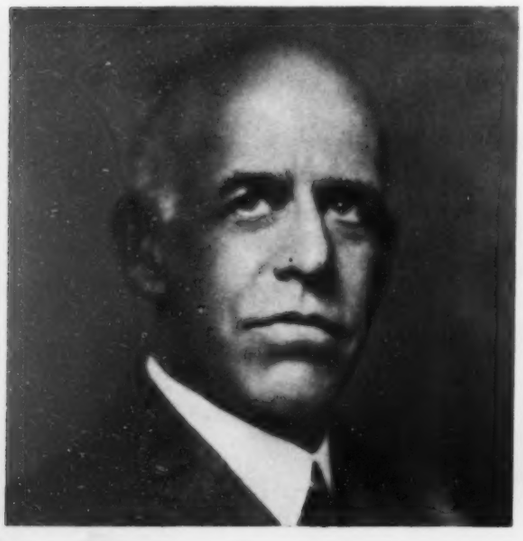

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A TRIBUTE TO THE NATIONAL SAFETY COUNCIL

The Banquet of the Association's Annual Convention to be held September 30th at the Stevens Hotel is programmed to commemorate the founding of the National Safety Council.

At the Convention Banquet held in Milwaukee, Wisconsin, September 30, 1912, a Resolution recommending the formation of a committee to establish a National Safety organization was drafted by Mr. Gano Dunn who was toastmaster at the Banquet.

Mr. Dunn will be the Toastmaster of the Banquet this year also. Included in the program are several men of national prominence all of whom are closely identified with safety work, and their discussions will give a brief history of the development of safety organization in the Steel Industry, how this movement led to the forming of the National Safety Council, the growth and achievements of the council, its present day problems, and what Safety has contributed to Industry.

The members of the Association can well be proud of the service we were privileged to give to the Safety Movement which has resulted in the formation of the National Safety Council, which today is recognized as an indispensable national asset.

Included in the Association's guest list are a number of high officials of the steel companies and men prominent in the work of the National Safety Council.

INLAND'S

76" Continuous Strip Mill

IN OPERATION SINCE 1932

This recent aerial view of the Indiana Harbor plant shows location of the 76" mill, also Inland's new 44" mill now under construction.

INLAND STEEL COMPANY

FIRST NATIONAL BANK BUILDING

CHICAGO

July 22, 1937

Association of Iron and Steel Engineers
Empire Building
Pittsburgh, Pennsylvania

Gentlemen:

My associates and I are very happy to welcome the members of your association to the Chicago steel manufacturing district, and to extend to them a most cordial invitation to visit our Indiana Harbor Works on October 1.

Judging by the program arranged to date, the 33rd Annual Convention to be held here at the Hotel Stevens beginning September 28, may well prove to be the most completely successful meeting of the many outstanding sessions which your fine group has had.

I have always been particularly interested in your work, and impressed with the high calibre of your activities. There is still so much to be accomplished in the art of steel making, and your organization with its fine membership and its Iron and Steel Engineer magazine represents a splendid medium for the exchange of the most advanced information on steel mill practice.

We look forward to the coming sessions, and a careful study of the equipment and materials offered through your exhibits.

I hope every one of your members may be able to pay us a visit at Indiana Harbor.

Very truly yours,

R. J. Block
President

P.D. BLOCK
President
NLAND STEEL CO.

INLAND'S

76" Continuous Strip Mill

▲ INLAND STEEL really began with Chicago's Columbian Exposition of 1893. The Blocks, founders and present management of Inland, had been engaged in a steel forging business in Cincinnati.

When Joseph Block came with his two sons to see Chicago's exposition he, like many thousands of others, was impressed by the Middle West's quickening progress. But he also saw that lack of materials was hampering the growth of a wide variety of industries.

Before the close of that year he had joined with others in building the first unit of the new steel company, a mill for re-rolling rails at Chicago Heights. Its initial capacity was about 20,000 tons per year. Since then it has grown to a capacity of more than 100,000 tons, supplying an economical and thoroughly satisfactory material for the manufacture of agricul-

E. L. RYERSON, JR.
Vice Chairman

L. E. BLOCK
Chairman of Board

tural implements, bedsteads, steel fence posts for the farmer, and a host of other products.

In 1901 the first construction took place at Indiana Harbor, the beginning of a complete modern steel plant, and the first one to be built on that barren dune land which is now one of the country's most important steel-producing areas.

The Inland that the Blocks built continued to grow from these two beginnings, grew as its customers grew, both in number and in size. This point is important, for having grown up with them, Inland has understood and taken keen interest in its customers' problems, and has constantly adapted steelmaking facilities to their requirements.

The Indiana Harbor plant now occupies more than a square mile and can produce more than 2,000,000 tons of steel annually—bars, shapes, plates, sheets, strip, rails and accessories, piling, tin plate, etc. Behind this plant are properties accumulated through the years to supply needed raw materials: Minnesota and Michigan ore mines, Kentucky coal mines, Michigan stone quarries and ships to carry the freight by water.

Typical of Inland's alert development of facilities to meet the growing demands of the steel market are improvements installed in recent years, a continuous bar mill in 1930, the 76-inch continuous strip mill during the depth of the depression in 1932, new tin mills in 1933, a new blooming mill, nine new soaking pits and four new open hearths in 1936, new blast furnace, additional new 5 open hearths, and battery of coke ovens in 1937, and a new 44-inch continuous strip mill now under construction to begin operation early in 1938.

The 76″ strip mill is housed in a group of buildings covering an area of approximately 340,000 sq. ft. The mill has a rated capacity of 50,000 tons per month, and is designed for rolling plates 3/16″—3/4″ in thickness up to 72″ in width, and strip .042″ x 18″—36″, and up to .076″ x 74½″. Tonnage is essentially low carbon steel, with some manganese steels also being rolled. Actually, tonnages in excess of 70,000 tons per month have been rolled.

BLOOMING MILL

Slabs are furnished from a 46″ blooming mill which lays directly in line with the strip mill. The mill is

W. SYKES

Assistant to President in Charge of Operations

J. L. BLOCK

Executive Vice President in Charge of Sales

J. H. WALSH
Works Manager

a 46″ x 104″ slabbing stand, driven by a 7000 H.P., D.C. motor, through Ward-Leonard control. An innovation in blooming mill practice lies in the use of Ward-Leonard control on the screw-downs, side-guards, live tables, and shear of this mill. While this type of installation entails a higher first cost than the usual magnetic control system, it was felt that the speed of operation, lower maintenance, power reduction and flexibility offered by the Ward-Leonard system would result in greater overall economy.

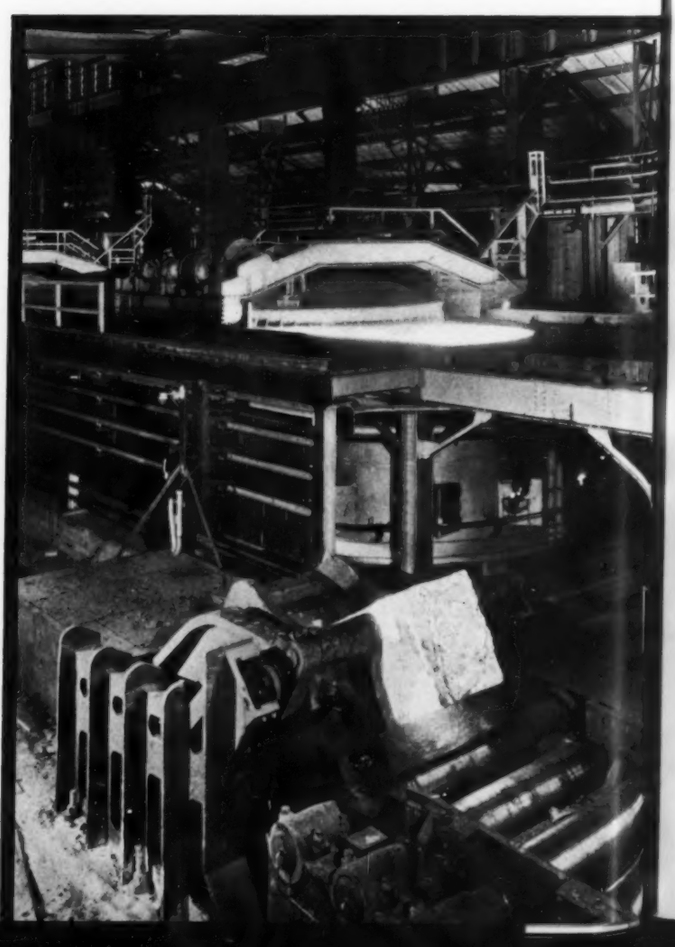
The screwdowns are driven by two 150 H.P., 450 R.P.M., 230 volt shunt motors, each equipped with a shunt brake. Each motor is supplied with power from an individual 135 K.W., 3-field generator. Sideguards are each driven by two similar motors, connected permanently in series. Each pair of motors is supplied from one 135 K.W. generator. Front and rear tables are each driven by two similar motors, also permanently connected in series, with a 135 K.W. generator for each pair. The slab shear, which was designed for sections up to 6″ in thickness (and has actually sheared a 10″ slab on test), is driven by two 275 H.P., 435 R.P.M., 250 volt shunt motors, each with a shunt brake, and each supplied from a 250 K.W., 3-field generator. All of these generators have, in addition to the usual separately excited shunt field, a self-excited shunt field and a heavy series differential field, in order to obtain the desired volt-ampere characteristics.

ROTARY SOAKING PITS

Serving this blooming mill are nine circular ingot heating pits (Provision has been made for six additional pits, quite necessary when mill operates 3 turns daily), arranged in a single line, each 16 ft. in diameter and capable of holding ten ingots, 26″ x 54″ x 72″. The sides and bottom of each pit are enclosed in a steel shell, reinforced with heavy channels and angles. Refractories throughout the pits are of first quality firebrick, except in the bottoms, where some use is made of chrome brick. About 5″ of graduated insulating brick lies between the firebrick and the steel shell. The dome-shaped pit covers are lined with first quality firebrick, covered over with insulating brick, and held in place by means of a 2½″ thick steel ring. Cover edges rest in a cast iron sand seal which encircles the pit. Covers are operated by three lifting mechanisms which run on 6″ x 10″ bloom rails the full length of the line of pits. Each mechanism is equipped with a 15 H.P. hoist motor and a 7½ H.P. traverse motor. The control panel for these motors is mounted on a platform on the mechanism, on which the operator also rides. Cover mechanisms are so interlocked as to be inoperable until the cover has been raised clear of the sand seal.

Each pit is fired with fourteen combination oil and coke oven gas burners, and either fuel may be used as desired, with no apparent difference in surface quality of the ingots. Air for combustion, which is not preheated in pits of this type, is furnished at 16 ounces pressure, by motor driven blowers. All burners fire tangentially

Newest type rotary soaking pits installed at 46″ blooming mill. Reheated ingot is seen on buggy car in foreground, ready to be conveyed to blooming mill.



through the furnace shell into a circular combustion chamber which is formed outside of the 16 ft. diameter pit, and extends about 2 ft. above the pit bottom. The tangential setting of the burners, plus the construction of the combustion chamber tend to give even and rapid circulation of gases throughout the furnace. Furnace temperature is automatically controlled from a platinum thermo-couple. Furnace pressure is also automatically controlled separately for each pit.

At the base of each pit a clean-out door is provided. Cinder is removed each time bottom is made, which is approximately every 32 hours. Coke breeze requirements average under thirteen pounds per ton of ingots heated.

Three stacks handle waste gases from the nine pits, the flues being so arranged that banks of three pits are vented through one stack. Provisions have been made in the foundations for the installation of waste heat boilers, one for each three pits, if desired.

Overall averages have shown a production of fifteen gross tons of steel heated per hour per pit.

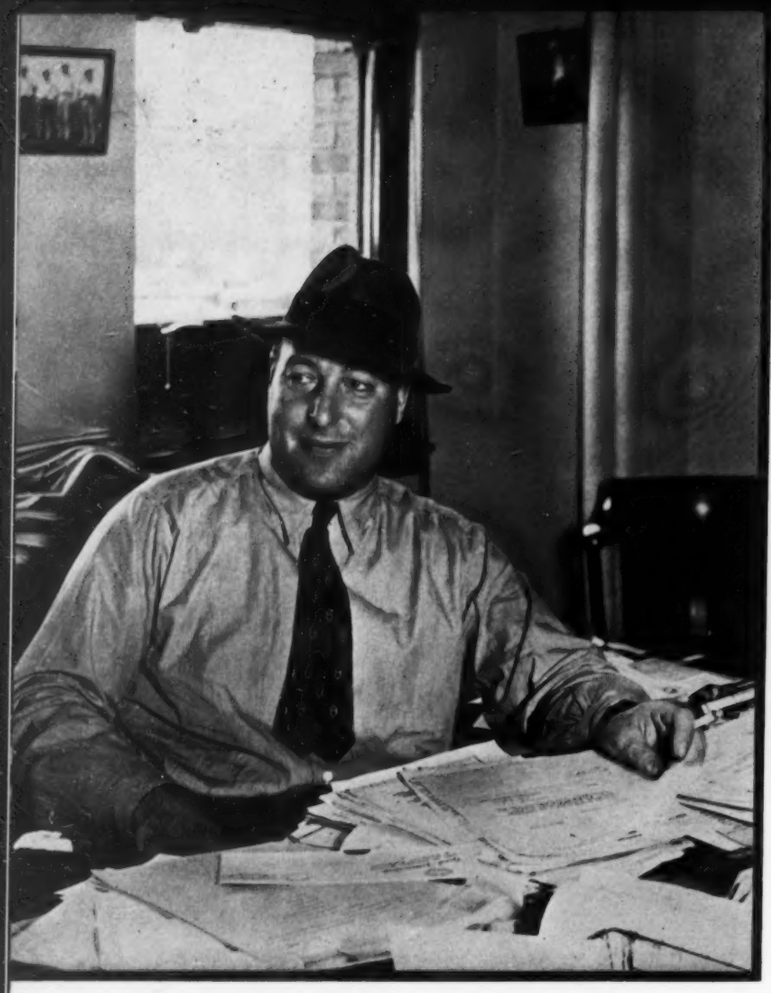
STRIP MILL

Slabs may vary in size from 18″ x 3″ x 60″ to 41″ x 4½″ x 168″. Weights may vary from 1000 lb. to a maximum of 7500 lb., depending on the final width and gauge to be rolled. Slabs are delivered to the closed slab yard, which is approximately 85 ft. wide x 650 ft. long, by a transfer directly from the blooming mill tables. Two 25-ton cranes, equipped with magnet controls, handle the slabs through the yard and on to a magazine charger which supplies slabs to the furnace charging table. The magazine lift is driven by a 50 H.P. compound D.C. motor, through a rack and pinion arrangement, while a 10 H.P. series motor drives the magazine chain which kicks the slabs onto the charging tables. The chain is interlocked with the lift so that it cannot operate unless the lift is in proper position. The charging table is divided into three sections, each driven by a 50 H.P. compound motor. These charging tables project back into the slab yard, as does the transfer from the blooming mill tables. This arrangement reduces slab handling to a minimum.

There are three continuous heating furnaces of the triple-fired type, fired with fuel oil, and each having a rated capacity of 50 tons per hour. Twenty oil burners are installed on each furnace, six being spaced across the furnace overfiring the heating zone, six more similarly spaced underfiring the heating zone, and eight more overfiring the soaking zone. Hearths are practically level, and are 77 ft. long x 18 ft. wide. The hearth length is divided into a heating zone 60′–7″ long and a soaking zone 16′–4″ long. The furnaces are well insulated. Furnace roofs are of flat suspended arch construction. Each furnace is equipped with refractory tile recuperators, in which air for combustion is heated to 700-800 degrees F. Oil is supplied at a pressure of 150 lb. per sq. in. in a circulating system. Air for combustion is provided by a fan. Fuel consumptions as low as 12 gallons of oil per ton of steel have been obtained. A double head pusher is on each furnace, and the heads may be operated either together or separately, so that the furnace may be charged in

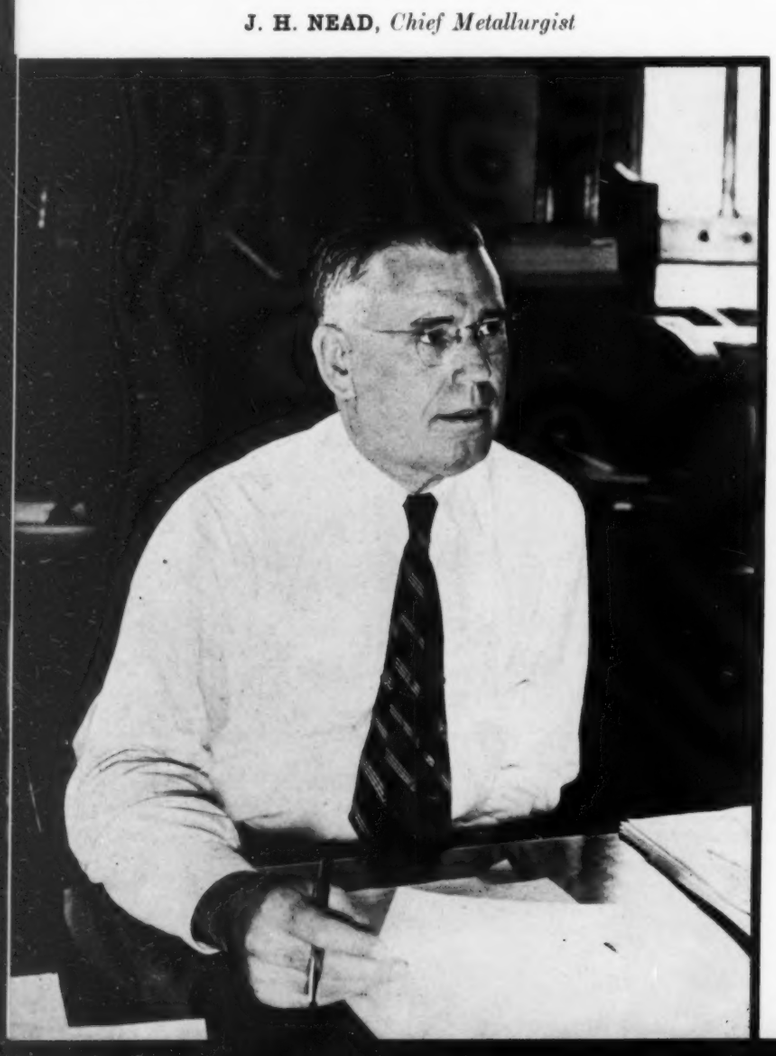
H. R. de HOLL,
General Superintendent

Closeup view of 46″ blooming mill. This mill lays directly in line with the 76″ hot strip mill.



F. M. GILLIES, *Assistant General Superintendent*

J. H. NEAD, *Chief Metallurgist*



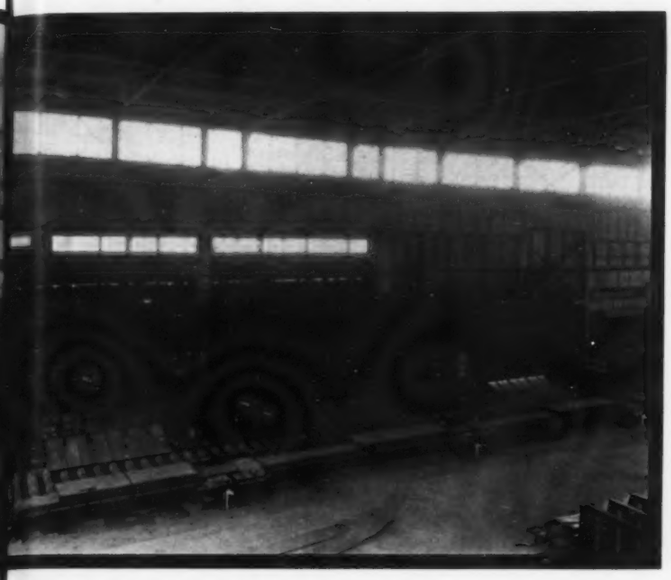
Strip passing through six finishing stands. The heavy plate enters the first finishing stand shown at left and passes through six stands before going to the hot bed.

either one or two rows. Each pusher head is driven by a 50 H.P. series motor, which is interlocked with furnace door hoists so that it cannot be operated until doors are open. The discharge ends of the furnaces project into the hot mill building, and skid plates are specially designed so as to allow discharge of the slabs without undue shock to the roller table.

ROUGHING TRAIN

Slabs at temperatures of about 2250 degrees F. are discharged from the furnaces and proceed to the hot mill. A slight reduction (usually about $\frac{1}{8}$″) is first effected in a 2-high 23″ x 76″ scale breaker, driven by a 1000 H.P., 6600 volt, 375 R.P.M. wound rotor induction motor. Hydraulic jets at 1000 lb. pressure remove primary scale after this pass. Following this is a broadside mill, a 4-high stand of the universal type, 49″ and 36″ x 95″, driven by a 3000 H.P. 6600 volt, 150 R.P.M. wound rotor induction motor. Slabs up to 87″–90″ in length may be cross-rolled in this stand so as to bring the slab to a greater width than originally supplied. To move slabs into position for cross-rolling, turntables are installed before and after the broadside stand, each driven by a 7½ H.P. motor, with the lifts operated hydraulically. A slab pusher, driven by a 200 H.P. compound D.C. motor, precedes the broadside mill and insures proper entry of short slabs into the mill. Following the broadside mill is a slab squeezer which squares up the edges and corrects the width of the slab. The squeezer is driven by a 265 H.P. compound D.C. motor. Hydraulic operations on the turntables, sprays, and squeezer are controlled by means of ½ H.P. series thrustors which operate the various hydraulic valves.

Slabs then proceed on to the three remaining roughing stands. These stands are 4-high, 49″ and 25″ x 77″, each driven by a 3000 H.P., 6600 volt, 500 R.P.M. wound rotor induction motor. All roughing stands



iew from above of three slab reheating furnaces. These furnaces are fired with fuel oil and have a capacity of 50 tons per hour.

A. P. MILLER

Assistant General Superintendent

are spaced so that the slab is in only one stand at a time, center distances being successively 31′–4″, 40′–11″, 46′–6″, and 70′–6″ between stands of the roughing train. These stands are driven through gear sets, and are equipped with flywheels of 45000-50,000 H.P.-seconds. Slip regulators are employed, and are usually set to pick up at about 100% motor load, at which setting the electrodes seldom move.

All roughing stands are of the universal type, with vertical edger rolls 22″ in diameter on the entry side, integral with the mill stand, each driven by a 150 H.P. adjustable speed compound motor mounted on top of the mill stand. Edger roll speed is synchronized with main roll speed through the same control system.

Leaving the roughing train, the slab passes over a roller table about 99 ft. long, leading to the finishing train. This table serves as a cooling table, on which the steel temperature is allowed to drop to the proper point for finishing. Steel thickness at this point is usually .65″–.85″, depending on finishing gauge and temperature.

A second scale breaker, 2-high, 24″ x 76″, and driven by a 500 H.P., 600 volt D.C., 150/450 R.P.M. motor precedes the finishing train.

FINISHING TRAIN

The finishing train consists of six 4-high stands, 49″ and 24½″ x 77″. each driven through a gear set by a 3500 H.P., 600 volt, D.C., 175/350 R.P.M. motor. Screwdowns on each stand are driven by 75 H.P., 500 R.P.M. compound motors. Screws on each side of the stand are coupled together through a magnetic clutch. Screwdown gauges are calibrated in thousandths of an inch. Between each finishing stand is located a constant torque motor operated looper rated at 200 ft. lb. Power is supplied to the looper motors at 55 volts from two special 25 K.W., 55 volt generators, each driven by a 40 H.P., 440 volt, 1450 R.P.M. induction motor. The looper between the last two stands, however, is usually inactive except as its roll is used to support the strip passing over it, as the material is

Slab runout table and pilers for 46″ blooming mill. The piler lift is driven by a 50 H.P. motor.

H. W. JOHNSON,
Superintendent of Blast Furnaces

ordinarily rolled in tension. The tension is only sufficient to prevent increase in width of the strip, but increases the load on the last stand drive by 200-300 H.P. The finishing stands are spaced on 18 ft. centers.

Mill speeds, ratios, etc., are as given in the following:

Stand	Motor R.P.M.	Roll R.P.M.	Mill Speed Ft. per Min.
Scale breaker	375	42.27	254.5
No. 1	150	19.11	180.
No. 2, 3 and 4	500	64.11	420.
Scale breaker	150/450	16.91/ 50.73	106/ 318
No. 5	175/350	27.6 / 55.2	177/ 354
No. 6	175/350	43.7 / 87.5	280/ 560
No. 7	175/350	59.4 /118.8	381/ 762
No. 8	175/350	76.4 /152.8	489/ 978
No. 9	175/350	91.7 /183.5	587/1174
No. 10	175/350	105.4 /210.8	676/1352

Tachometers installed on each stand indicate the mill speed.

Finishing temperatures of the strip range 1350-1700 degrees F., depending on composition and gauge of the product.

Roller bearings are used on the back-up rolls of the broadside mill, and on both back-up and work rolls of

TABLE A	Tons per Dressing	Total Life
No. 1 Stand, Back-up Rolls	90,000	2,000,000
No. 2-3-4 Stand, Back-up Rolls	50,000	1,000,000
No. 5-6-7 Stand, Back-up Rolls	40,000	1,000,000
No. 8-9 Stand, Back-up Rolls	20,000	1,000,000
No. 10 Stand, Back-up Rolls	15,000	1,000,000
No. 1 Stand, Work Roll	65,000	300,000
No. 2 Stand, Work Roll	25,000	65,000
No. 3-4 Stand, Work Roll	15,000	65,000
No. 5-6-7 Stand, Work Roll	1,200	65,000
No. 8-9 Stand, Work Roll	1,000	70,000
No. 10 Stand, Work Roll	800	75,000
Scale Breakers	150,000	1,200,000

General view of motor room. All hot mill main drive motors with their gear sets are located here.

all other stands. All back-up rolls are ground straight, as are all bottom work rolls and all scale breaker rolls. The top work rolls depending on width and gauge rolled, are ground with suitable crowns. All rolls in the finishing train have been changed in the record time of 36 minutes.

The average tonnage per dressing or grinding and total life of back-up and work rolls for the stands is listed in Table A on the opposite page.

Reductions on the strip through the mill range 30—40% in each pass of the roughers, increasing with the initial slab thickness, which may range 3″ to 6.5″. Reductions in the finishing stands run 40—50% in No. 5 stand, 33—35% in No. 6 and 7 stands, 28—33% in No. 8 stand, 20—25% in No. 9 stand, and 4—9% in No. 10 stand. The latter reductions are somewhat less when plate is being rolled.

Hydraulic requirements are met by two 1,000 G.P.M., 1,000 lb. pressure pumps, each driven by a 1000 H.P., 750 R.P.M., 6600 volt wound rotor induction motor.

Leaving the hot mill, the run-out table, composed of individual variable frequency induction motor driven rollers, proceeds for a distance of about 350 ft., where there are located two 74″ coilers. These coilers have the capacity to take care of strip up to 650 ft. in length which may be rolled, but is ordinarily limited to No. 16 gauge. Coil dimensions are approximately 24″ inside diameter, 36″ maximum outside diameter, 18″—73″ in width, and about 3/16″ maximum stock thickness.

The variable frequency motors on the table rollers provide for a range in delivery speed of 345—1380 ft. per min. The generators providing variable frequency current to the roller drives are interlocked with the control of the last mill finishing stand, so that delivery table speed automatically matches mill delivery speed.

Paralleling this run-out table on each side is another table, to either of which the strip may be taken for flat finishing. The chain type transfer serving these tables is about 258 ft. long. The tables themselves project about 800 ft. beyond the hot mill, and each contains two roller levellers, an end shear, a flying shear, and a piler. Another table along the south side of the mill contains a side shear and an end shear.

The lower end of the run-out or hot bed building contains all the necessary equipment for finishing hot-rolled flat products. Facilities for pickling, scrubbing, and drying have been installed, as well as a normalizing furnace. The 2-high 29″ x 73″ and 30″ x 80″ cold mills are also installed at this point. Additional auxiliary equipment located here includes:

Two 72″ leveller, slitter and trimmer lines.
154″ squaring shear.
168″ shear.
54″ leveller, slitter and trimmer.
Two circle shears.
98″ x 156″ resquaring shear.
98″ resquaring shear.
Two 72″ trimming lines consisting of leveller, side and end shear, and piler.

Hot mill lubrication is provided principally by three separate oiling systems, each complete with its own storage tank, automatic pump, filter and cooler. Three grease systems are also installed.

The roll shop is well equipped to satisfy the requirements of both hot and cold mills. Equipment in the shop includes a 60″ roll lathe, three 28″ roll grinders, four 36″ roll grinders, and two 52″ roll grinders. The

E. J. GARDNER, *Superintendent, By-Products Coke Plant*

H. B. HUBBARD, *Superintendent of Steel Production*

shop is serviced by two cranes. There is also a 60″ roll lathe installed in the hot mill building.

HOT MILL MOTOR ROOM

Power is delivered from the plant power house at 6600 volts, 3 phase, 25 cycle to all A.C. motors 1000 H.P. and larger, and at 440 volts for smaller motors. All hot mill main drive motors, described elsewhere in this article, with their gear sets, are located in the motor room, which lays alongside the hot mill building and is approximately 600 ft. long x 60 ft. wide.

Power for the finishing train and for the variable frequency sets supplying mill delivery, hot bed approach tables and strip coilers is supplied by three dual motor generator sets, each consisting of two 2500 KW, 600 volt D.C. generators driven at 500 R.P.M. by a 5300 KW, 6600 volt synchronous motor. Finishing stand drives are so connected that under ordinary conditions the motors and generators will be operating in parallel. Each motor, however, can be supported from its individual 2500 KW D.C. generator if desired, or any combination of individual and parallel operation may be obtained. These motors are started with variable voltage on the D.C. generators, but all speed adjustment of the motors is made by field weakening with the generators operating at predetermined constant voltage between 450 and 600 volts.

The 3500 H.P. finishing drives are shunt wound, and in addition have a speed regulating winding. This winding is connected in series with an adjusting rheostat, this in turn being direct coupled to the main shunt field rheostat. With full field on the main motor, the regulating winding will be practically all cut in.

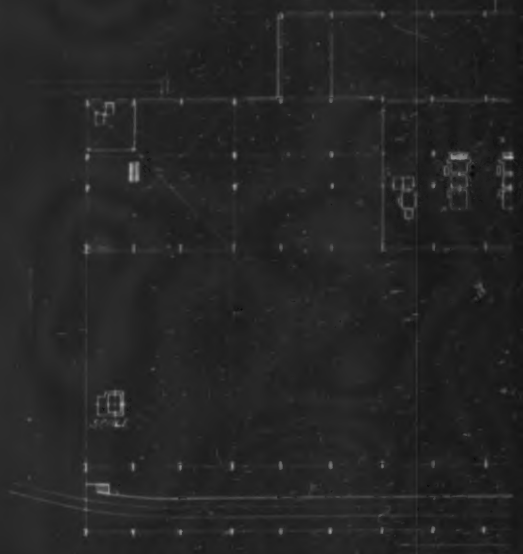
MAIN FEATURES OF THE CONTROL

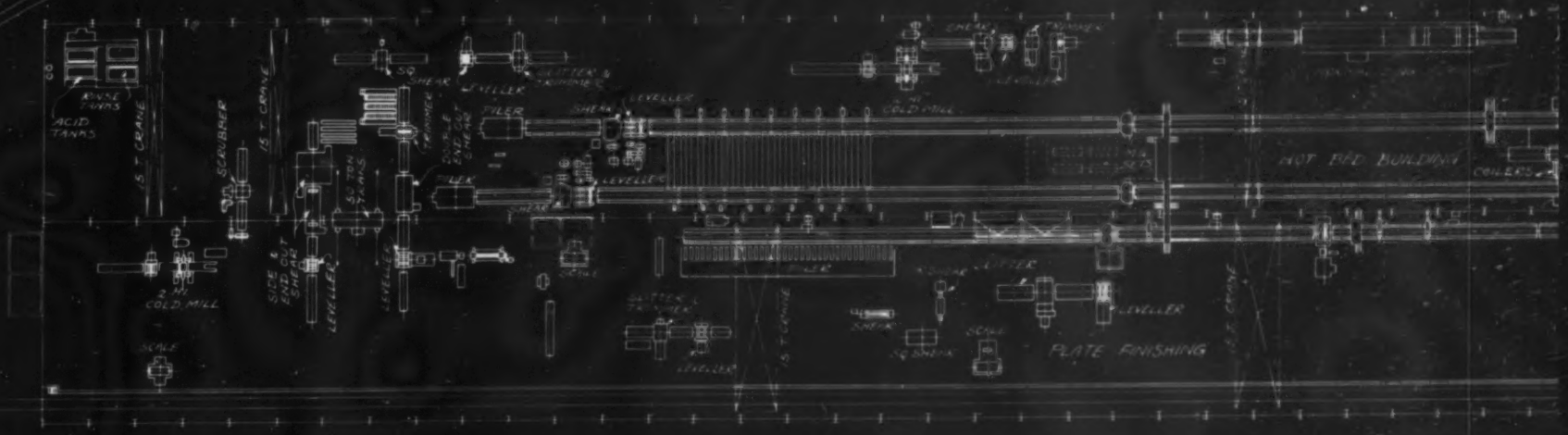
1. Equalizing winding on generators to equalize the load when motors are brought up to speed with gen-

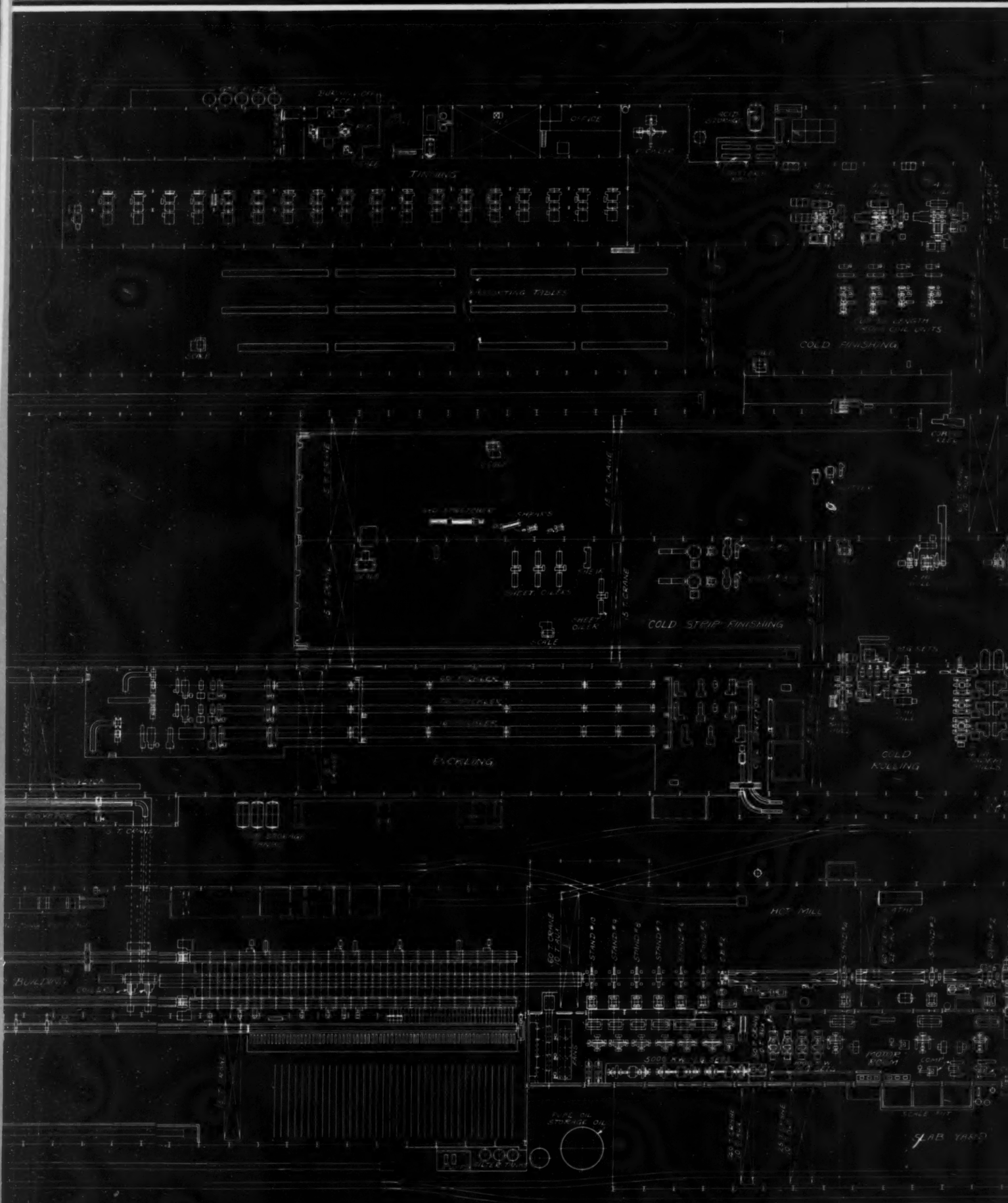
MILL DATA

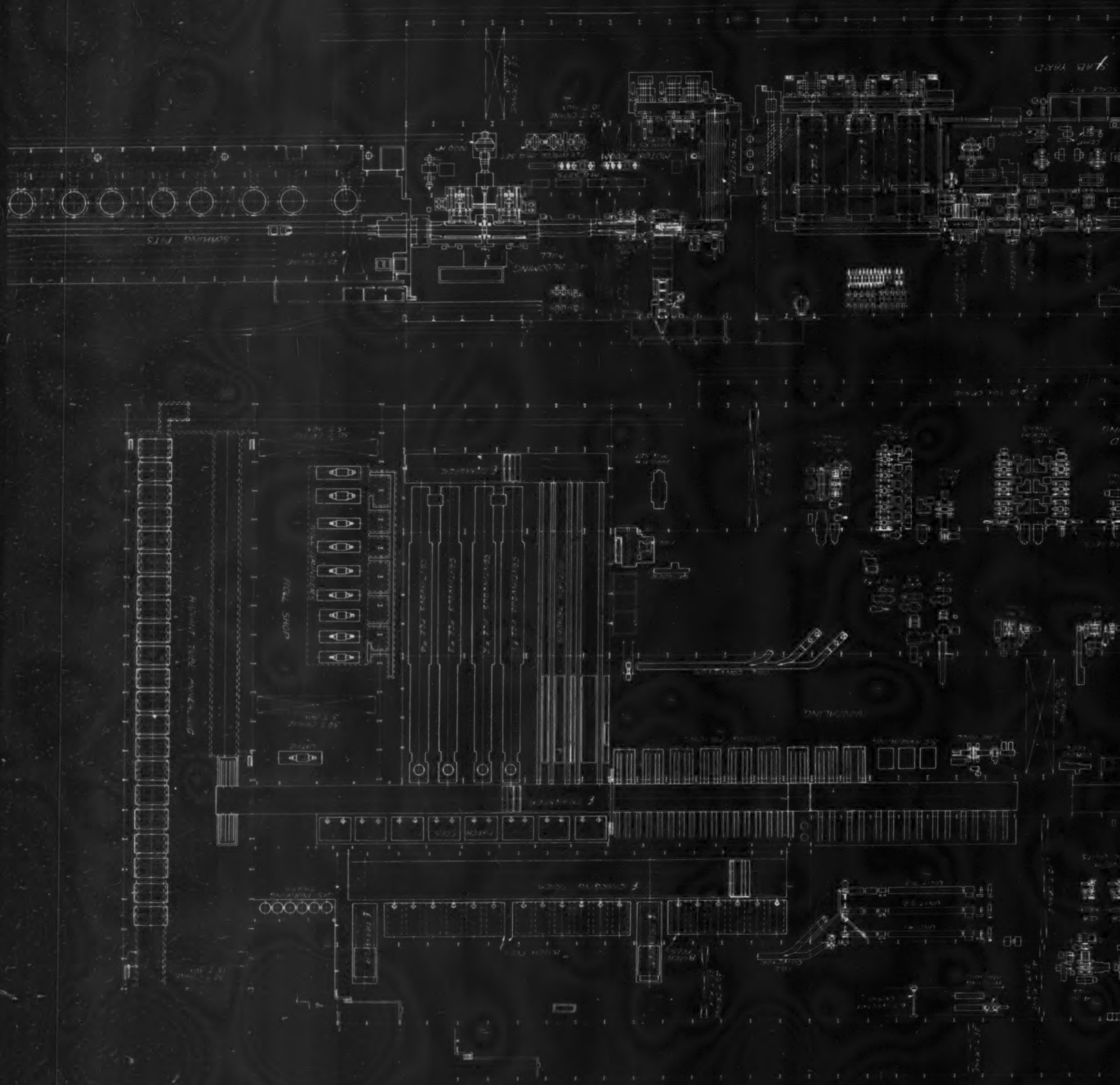
Stand	Characteristics	Roll Diameter		Roll Lgth.	Motor				
		Work	Back-up		H.P.	Volts	R.P.M.	Type	Remarks
HOT MILL									
Scale Breaker	1-Stand, 2-High	23″	.....	76″	1000	6600	375	Wound rotor ind.	Geared.
Broadside	1-Stand, 4-High	36″	49″	95″	3000	6600	150	Wound rotor ind.	Geared. Flywheel.
No. 2 Rougher	1-Stand, 4-High	24½″	49″	77″	3000	6600	500	Wound rotor ind.	Geared Flywheel.
No. 3 Rougher	1-Stand, 4-High	24½″	49″	77″	3000	6600	500	Wound rotor ind.	Geared Flywheel.
No. 4 Rougher	1-Stand, 4-High	25″	49″	77″	3000	6600	500	Wound rotor ind.	Geared Flywheel.
Scale Breaker	1-Stand, 2-High	24″	.....	76″	500	600	150/450	D. C.	Geared.
No. 5 Finisher	1-Stand, 4-High	24½″	49″	77″	3500	600	175/350	D. C.	Geared.
No. 6 Finisher	1-Stand, 4-High	24½″	49″	77″	3500	600	175/350	D. C.	Geared.
No. 7 Finisher	1-Stand, 4-High	24½″	49″	77″	3500	600	175/350	D. C.	Geared.
No. 8 Finisher	1-Stand, 4-High	24½″	49″	77″	3500	600	175/350	D. C.	Geared.
No. 9 Finisher	1-Stand, 4-High	24½″	49″	77″	3500	600	175/350	D. C.	Geared.
No. 10 Finisher	1-Stand, 4-High	24½″	49″	77″	3500	600	175/350	D. C.	Geared.
COLD MILLS									
Tandem Mill	4-Stands, 4-High	20″	44″	54″	1- 500 1- 750	600	400/800	D. C.	With reel. Geared.
					1- 800 1-1250				
Tandem Mill	3-Stands, 4-High	20″	44″	72″	(3)1250	600	400/800	D. C.	With reel. Geared.
Cold Mill	1-Stand, 4-High	20″	44″	72″	350	600	400/800	D. C.	With reel. Geared.
Cold Mill	1-Stand, 4-High	20″	44″	72″	350	600	400/800	D. C.	With reel. Geared.
Cold Mill	1-Stand, 2-High	27″	.....	54″	60/125	250	225/900	D. C.	With reel. Geared.
Cold Mill	1-Stand, 2-High	27″	.....	54″	60/125	250	225/900	D. C.	With reel. Geared.
Steckel Mill	1-Stand, 4-High	12″	34″	39″	1000	600	400/800	D. C.	Geared to working rolls
Planish Mill	1-Stand, 4-High	18″	39″	42″	250	250	850/1400	D. C.	With reel. Geared.
Planish Mill	1-Stand, 4-High	18″	39″	42″	250	250	850/1400	D. C.	With reel. Geared.
Planish Mill	1-Stand, 4-High	18″	39″	42″	250	250	850/1400	D. C.	With reel. Geared.
Tandem Mill	5-Stands, 4-High	18″	49″	40″	(3)750 (2)500	750	400/800	D. C.	With reel. Geared.
Cold Mill	1-Stand, 2-High	29″	.....	73″	200	440	730	A. C.	Geared.
Cold Mill	1-Stand, 2-High	29″	.....	73″	200	440	730	A. C.	Geared.
Cold Mill	1-Stand, 2-High	30″	.....	80″	200	440	730	A. C.	Geared.
Cold Mill	1-Stand, 4-High	20″	44″	72″	200	600	400/800	D. C.	Geared.

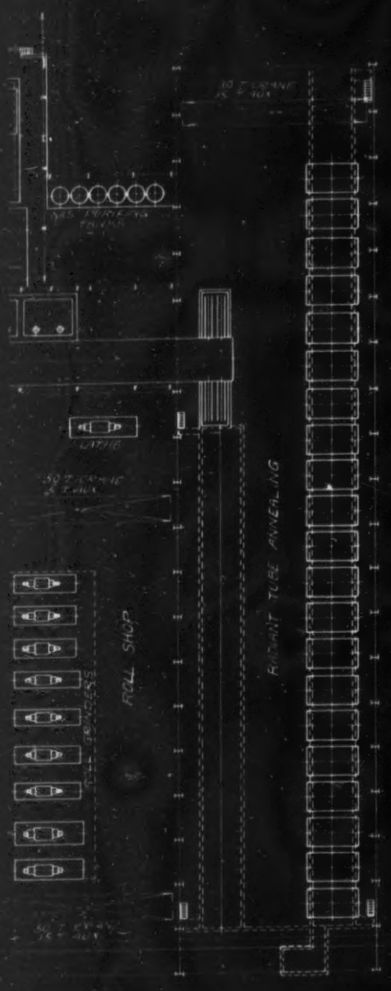
PLAN VIEW
STRIP & TIN MILLS
INLAND STEEL COMPANY
INDIANA HARBOR, INDIANA

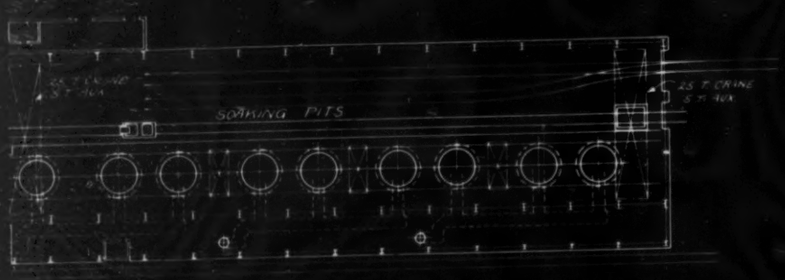





TINNING
COLD FINISHING
COLD STRIP FINISHING
PICKLING
COLD ROLLING
HOT MILL
SLAB YARD




ROLL SHOP
BRIGHT TUBE ANNEALING


SOAKING PITS
25 T CRANE
5 T AUX

SUMMARY OF CONNECTED 6600-VOLT LOAD

	K.V.A.
No. 1 Scale Breaker	
1000 H.P. x .746, 86.5% P.F.	860
No. 1 Stand	
3000 H.P. x .746, 84% P.F.	2650
No. 2, 3, and 4 Stands	
3 x 3000 H.P. x .746, 92.5% P.F.	7260
Finishing Stands, 3 x 5300 K.V.A.	15900
Spray Pumps	
2 x 1000 H.P. x .746, 92% P.F.	1640
Cold Mill M.G. Sets	
3 x 1750 H.P. x .746	3910
1100 H.P. x .746	822
3600 H.P. x .746	2680
1250 H.P. x .746	933
4400 H.P. x .746	3392
Auxiliary M.G. Sets. 3 x 1070	3210
Power and Light Transformers, 6600 volt primary	
6—1000 K.V.A. for Power	6000
3—200 K.V.A. for Light	600
Total 6600 volt connected load.	49857

erators operating in parallel and before regulators become operative at the pre-determined full generator voltage. This winding becomes inactive when motors are operated individually from their supporting generator. It also assists the voltage regulators when the generators are operating in parallel at the pre-determined full voltage.

2. Equalization at constant voltage with regulators. These voltage regulators are so arranged that they may be adjusted for five different operating voltages in steps, from 450 volts to 600 volts maximum. Compensating winding is automatically cut out during individual operation, and regulators maintain constant voltage within ½%. Thus, load distribution is equalized among the various generators operating in parallel.

3. Special quick acting trip coils on all motor and generator circuit breakers are provided in order to furnish quick protection against flash-over. Ordinary trip coils were found not to be fast enough, and D.C. relays, connected across the interpole winding, were added in order to obtain high speed tripping.

4. In the operator's pulpit is located a bench board carrying a control set-up for individual or parallel operation, control of operating voltage through setting of voltage regulators, speed control of motors by motor operated main shunt field motor rheostat, and hand operated vernier rheostats on each motor.

Other equipment installed in the motor room includes:

One 250 KW, 250 volt D.C., 750 R.P.M. synchronous motor-generator set, supplying excitation for synchronous motors, D. C. generators, etc.

Three 1000 K.W., 250 volt D.C., 750 R.P.M. synchronous motor-generator sets supplying auxiliary power.

Four variable frequency motor-generator sets, each consisting of two 300 volt, 300/1200 R.P.M., D.C. motors driving 15/60 cycle alternators. Control boards, air compressors and other auxiliary equipment are also located in the motor room. Switchgear is of metal-clad type. The motor room is supplied with forced ventilation from motor-driven fans.

A summary of rotating electrical machinery in the strip and tinplate mills is as follows:

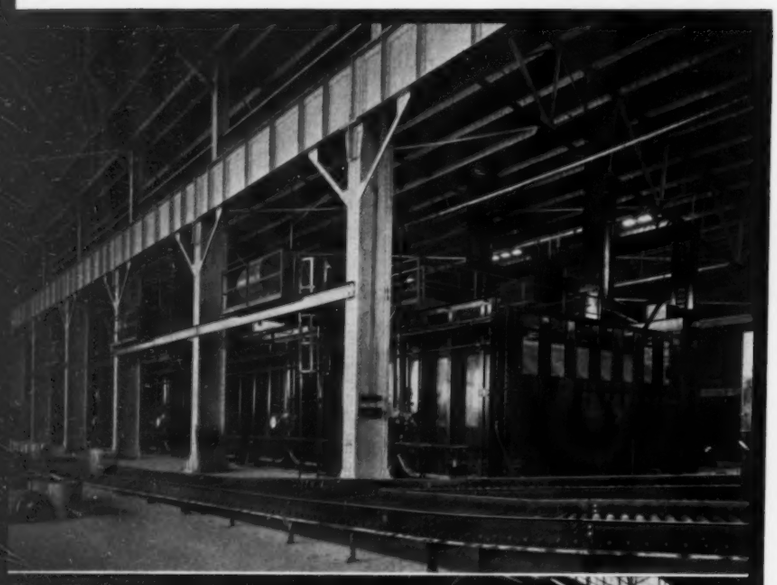
	Number	Total H.P.
Motors—Hot Mill	1008	75836
Generators—Hot Mill	35	29663
Total Hot Mill	1043	105499
Motors—Cold Mills, Finishing, etc.	858	34412
Generators— " " "	64	15670
Total Cold Mills, etc.	922	50082
Total Installation	1965	155581

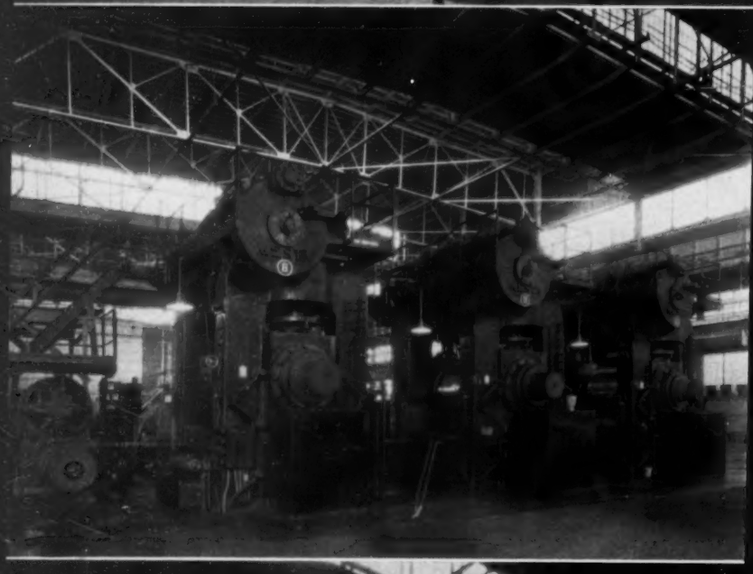
ANNEALING

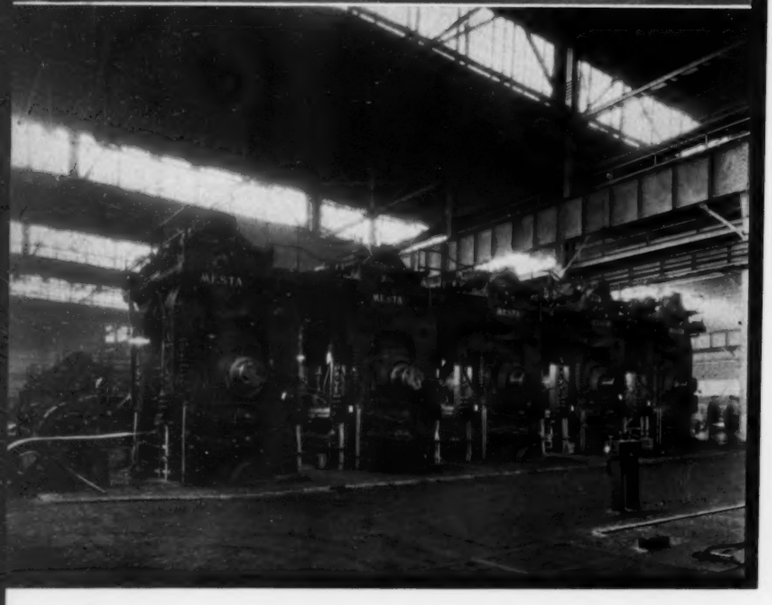
Annealing equipment consists of four continuous tunnel type furnaces used for the annealing of cold

Pickling units at cold strip mill showing welding of two coil ends together before entering continuous pickling tanks.

Front view of continuous pickler where hot rolled coils are started through pickling units.







Top — Annealing furnaces, showing portion of conveyor in foreground.

Center — Closeup of three stand tandem, cold strip mill.

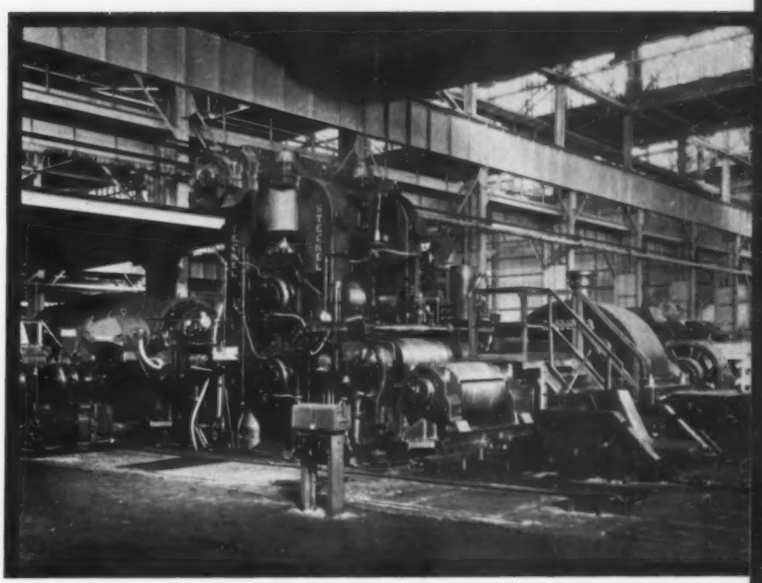
Below — Five stand tandem showing coil of steel being fed into first stand at left.

rolled sheets and coils; thirty-four batch type furnaces arranged in two rows, for annealing tinplate and cold strip stock either in coil or flat sheet form; nine radiant tube annealing covers, with twenty-eight bases, for annealing cold roll stock in coil or flat form. All these furnaces are fired with by-product coke oven gas coming from the plant coke ovens, and are equipped with automatic temperature controls. Transfers run across each end of the continuous furnaces, and, together with return tracks paralleling the furnaces, simplify the

H. S. AURELIUS

Superintendent, Blooming, Rail and Structural Mills

F. V. CARROLL
Chief Engineer



Steckel reversing cold mill which has a delivery speed of 1250 feet per minute.

problem of material handling in this department. Loading tracks and cooling tracks are conveniently located.

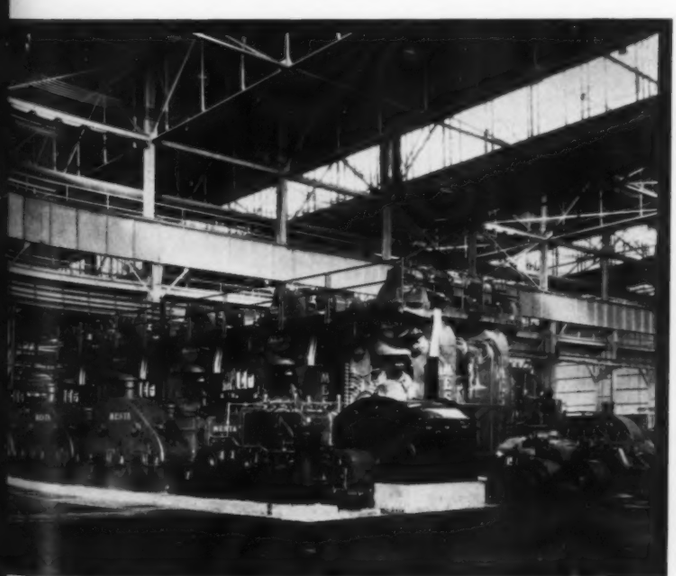
Gas-cracking units are installed to provide the necessary furnace atmosphere for deoxidizing.

COIL PICKLING

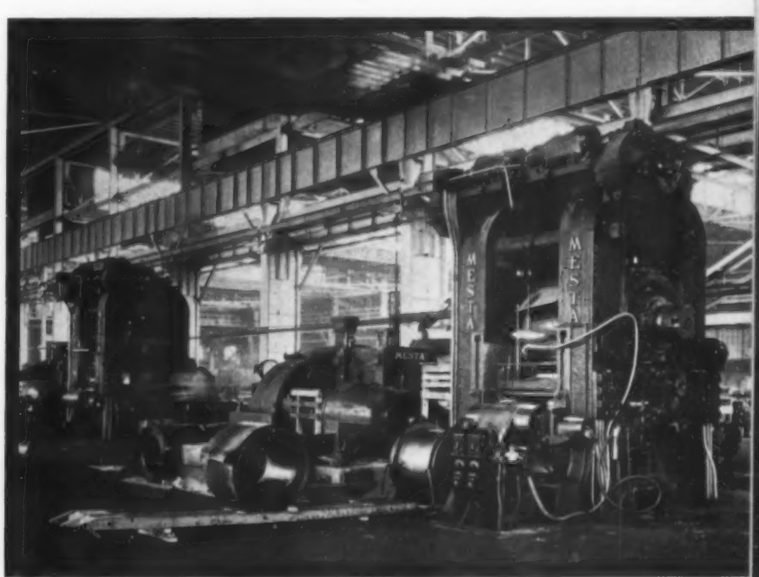
From the hot mill coilers, an underground conveyor over 300 ft. long takes coils to the coil storage, where they are deposited on a second conveyor about 300 ft. long paralleling the one building wall. The coil storage is about 105 ft. x 350 ft., and contains a trimming and slitting line.

Running on from the end of the coil storage is the pickling department, containing three continuous pickling lines, designated respectively as 60″, 72″, and 76″ units. Each line consists of the usual feed reel, stitching unit, pinch rolls and looping pit, followed by four acid tanks, a cold water tank, a hot water tank, and the drying, shearing and coiling equipment. The acid tanks are all 60 ft. in length, and of steel plate con-

Power side of five stand tandem cold strip mill. The mill operates at a delivery speed of 1100 feet per minute.



Closeup view of one of the two single 4-high stands.



struction lined with rubber and with a protective lining of brick set up in a special acid-resisting cement. The rollers which carry the strip between each tank are of steel entirely covered with rubber. Pickling solutions are normally 8—12% sulphuric acid at an automatically controlled temperature of about 180 degrees F. The water tanks are each 25 ft. in length, and of similar construction to the acid tanks. Tanks are provided with arched steel plate covers, rubber lined. The sewer serving this department is also rubber lined.

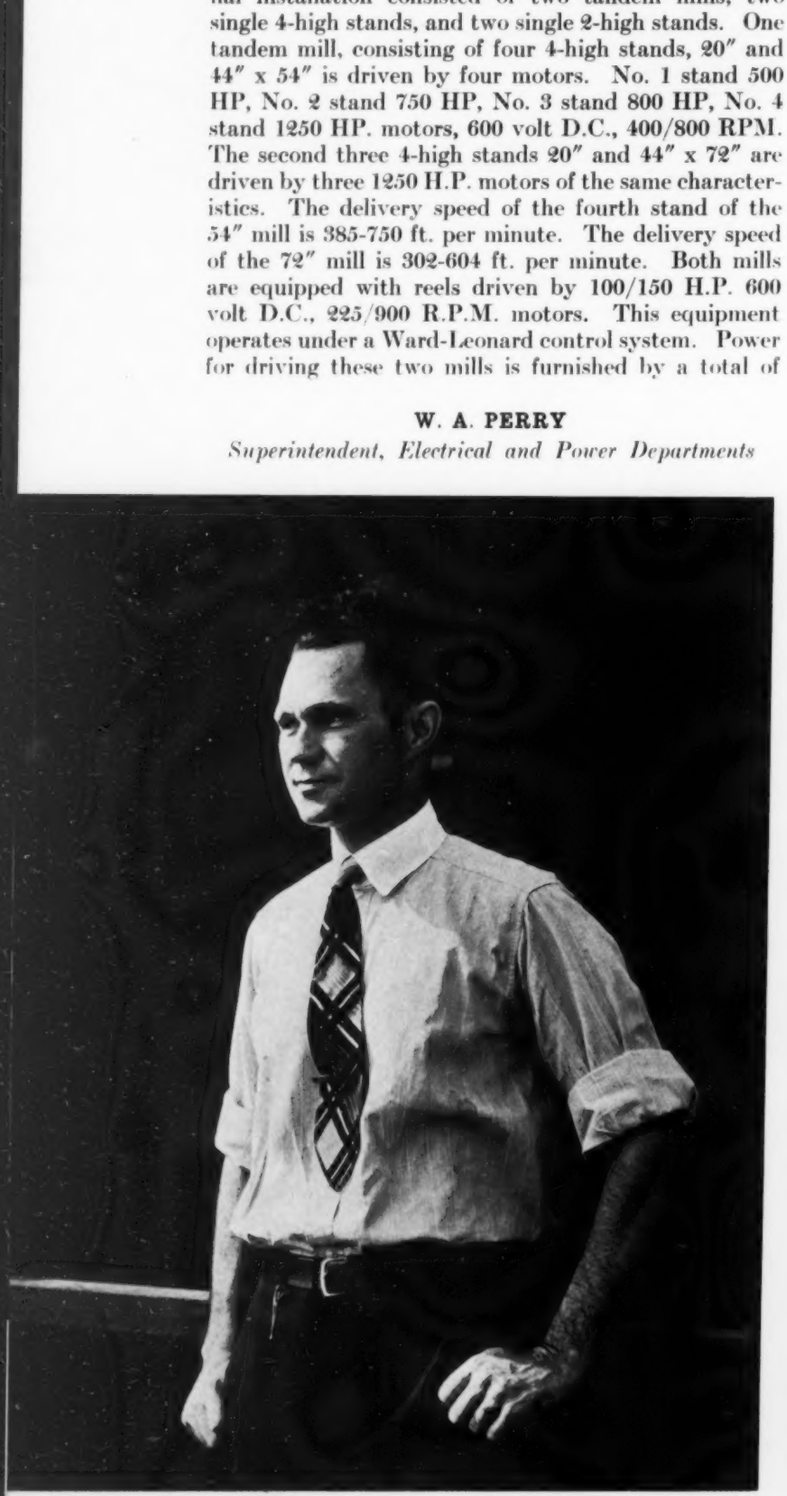
COLD MILLS

Cold rolling equipment is very complete. The original installation consisted of two tandem mills, two single 4-high stands, and two single 2-high stands. One tandem mill, consisting of four 4-high stands, 20″ and 44″ x 54″ is driven by four motors. No. 1 stand 500 HP, No. 2 stand 750 HP, No. 3 stand 800 HP, No. 4 stand 1250 HP. motors, 600 volt D.C., 400/800 RPM. The second three 4-high stands 20″ and 44″ x 72″ are driven by three 1250 H.P. motors of the same characteristics. The delivery speed of the fourth stand of the 54″ mill is 385-750 ft. per minute. The delivery speed of the 72″ mill is 302-604 ft. per minute. Both mills are equipped with reels driven by 100/150 H.P. 600 volt D.C., 225/900 R.P.M. motors. This equipment operates under a Ward-Leonard control system. Power for driving these two mills is furnished by a total of four motor generator sets, each of 1250 kw. capacity, two of the motor generator sets consisting of a 1250 kw. generator directly connected to a 1750 H.P. 6600 volt motor are used for driving one of the mills, the other mill is connected to a dual motor generator set consisting of two 1250 kw. generators driven by one 3600 H.P. 6600 volt 750 R.P.M. motor.

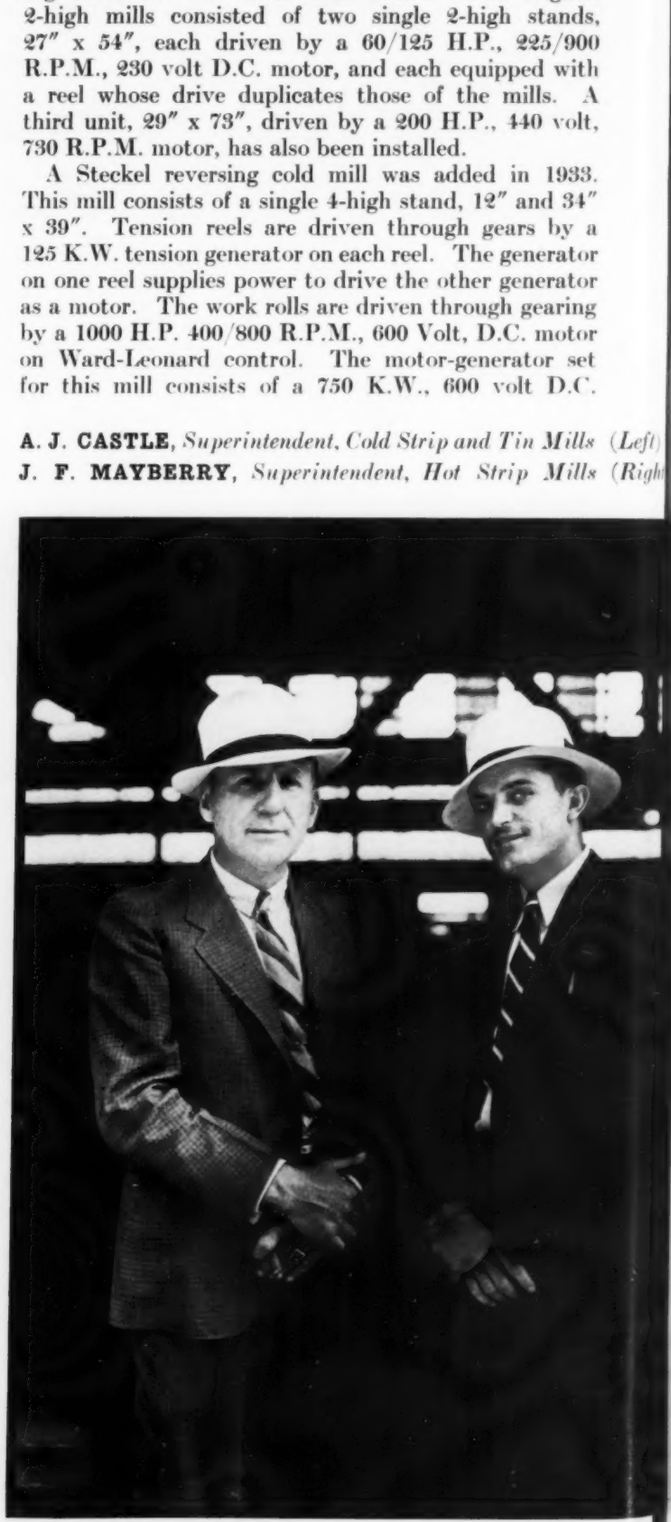
The two single 4-high stands are 20″ and 44″ x 72″, and each is driven by a 350 H.P., 600 volt D.C., 400/800 R.P.M. motor. Each is equipped with a reel duplicating those on the tandem mills, and power is furnished by a motor-generator set which is also a duplicate of those on the tandem mills. A third cold mill duplicating these two has since been added. The original 2-high mills consisted of two single 2-high stands, 27″ x 54″, each driven by a 60/125 H.P., 225/900 R.P.M., 230 volt D.C. motor, and each equipped with a reel whose drive duplicates those of the mills. A third unit, 29″ x 73″, driven by a 200 H.P., 440 volt, 730 R.P.M. motor, has also been installed.

A Steckel reversing cold mill was added in 1933. This mill consists of a single 4-high stand, 12″ and 34″ x 39″. Tension reels are driven through gears by a 125 K.W. tension generator on each reel. The generator on one reel supplies power to drive the other generator as a motor. The work rolls are driven through gearing by a 1000 H.P. 400/800 R.P.M., 600 Volt, D.C. motor on Ward-Leonard control. The motor-generator set for this mill consists of a 750 K.W., 600 volt D.C.

W. A. PERRY
Superintendent, Electrical and Power Departments



A. J. CASTLE, *Superintendent, Cold Strip and Tin Mills (Left)*
J. F. MAYBERRY, *Superintendent, Hot Strip Mills (Right)*



generator and an 1100 H.P., 6600 volt, 25 cycle, 750 R.P.M. synchronous motor, with a 40 K.W., 250 volt D.C. exciter. The mill can operate at a maximum speed of 1500 ft. per minute.

To increase facilities for the manufacture of tin plate, another tandem mill was installed in 1934. This mill consists of five heavy 4-high stands, 18″ and 49″ x 40″. The first and last stands are each driven by a 500 H.P. motor. The three intermediate stands are each driven by a 750 H.P. motor. The reel is driven by a 150 H.P., 225/900 R.P.M. motor. All drives are 750 volt D.C., 400/800 R.P.M. This mill can produce tinplate 36″ wide down to No. 38 gauge, and can operate at a maximum delivery speed of 1100 ft. per minute. Power for this mill is supplied by a dual motor-generator set consisting of two 1500 K.W., 750 volt D.C. generators driven at 750 R.P.M. by a 4400 H.P., 6600 volt synchronous motor.

At this time, three planishing mills were also installed, each consisting of a single 4-high stand, 18″ and 39″ x 42″, driven through a gear set by a 250 H.P., 850/1400 R.P.M., 250 volt D.C. motor. Each mill has a reel driven by a 75 H.P., 300/1200 R.P.M., 250 volt D.C. motor.

There are two additional 2-high single stand cold mills located in the run-out building of the hot mill, one 30″ x 80″, the other 29″ x 73″, each driven by a 200 H.P., 730 R.P.M., 440 volt A.C. motor.

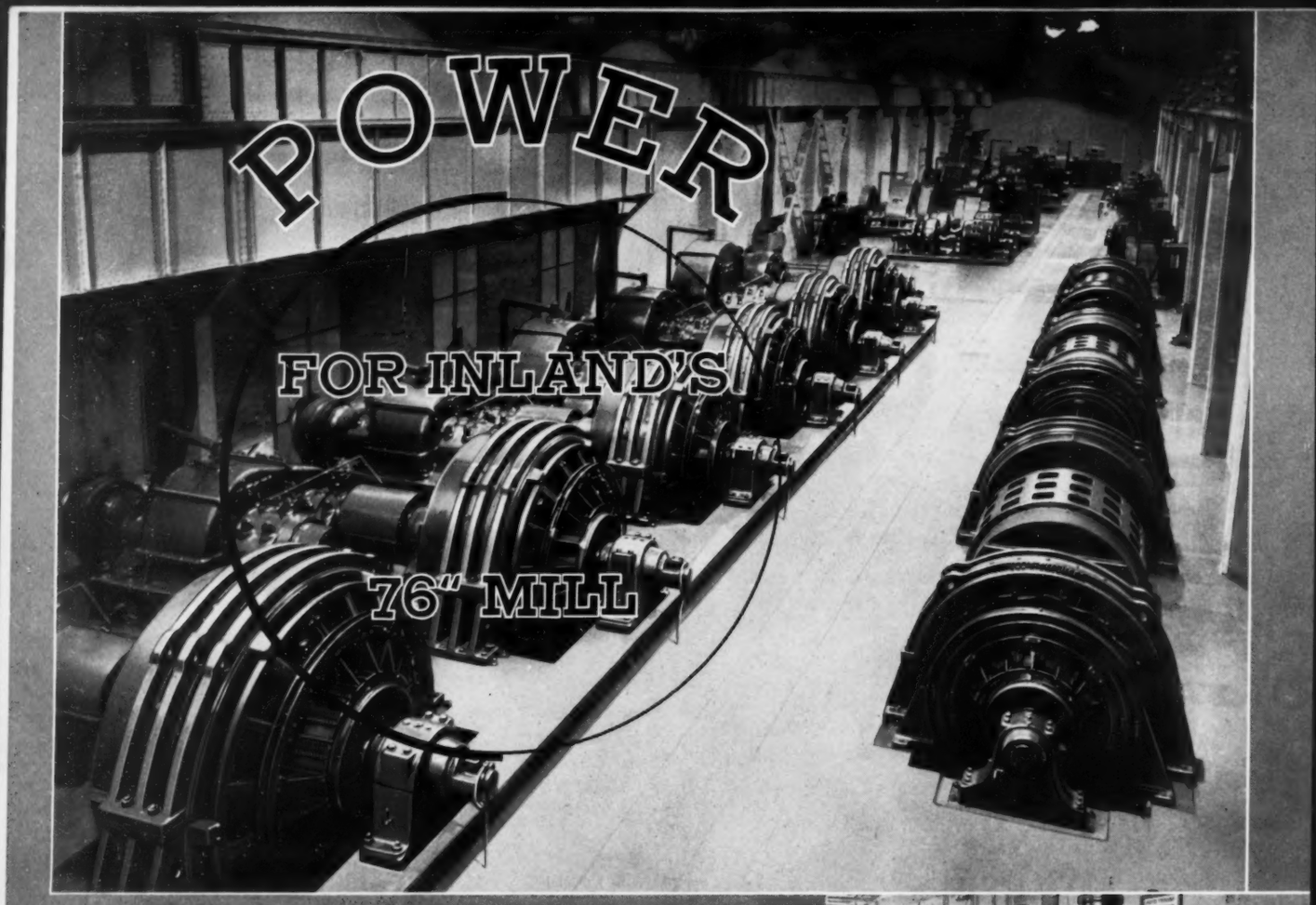
CRANES

Thirty-eight travelling cranes service the plant, being located as follows:

Location	Number	Capacity Tons	Approx. Span Ft.
Slab Yard	2	25/10	80
Slab Yard	1	40/10	80
Furnace Building	1	3	55
Hot Mill	1	60/25	100
Hot Mill	1	60/25	100
Motor Room	1	50/10	55
Hot Bed and Run-out Building	6	15	100
Machine Shop	1	2	20
Pickling Dept. and Coil Storage	3	15	100
Coil Conveyor Leanto	1	5	22
Cold Roll Dept.	1	60/25	100
Cold Roll Dept.	1	15	100
Coil Handling Leanto	1	10	17
Coil Handling Leanto	1	15	17
Cold Strip Finishing	5	15	100
Annealing Dept.	1	60/10	100
Annealing Dept.	1	30/15	100
Annealing Dept.	2	40/25	60
Roll Shop	2	50/15	100
Tinplate Finishing	2	10	100
Tinplate Finishing	1	25	40
Tin Plate Finishing	1	5	100
Machine Shop	1	2	40

MILL SPEEDS, RATIO, ETC., OF THE VARIOUS COLD MILLS

Mill	Motor R.P.M.	Roll R.P.M.	Mill Speed Ft. Per Min.
5-Stand Tandem, No. 1	400/800	19.3 / 38.6	91 / 182
5-Stand Tandem, No. 2	400/800	38.3 / 76.6	180.5 / 361
5-Stand Tandem, No. 3	400/800	62.89 / 125.78	296 / 592
5-Stand Tandem, No. 4	400/800	90.5 / 181	426.5 / 823
5-Stand Tandem, No. 5	400/800	115. / 230.	542 / 1084
54″ Tandem, No. 1	400/800	22.86 / 45.72	120 / 240
54″ Tandem, No. 2	400/800	39.6 / 79.2	206 / 412
54″ Tandem, No. 3	400/800	56.4 / 112.8	295 / 590
54″ Tandem, No. 4	400/800	74. / 148.	385 / 770
72″ Tandem, No. 1	400/800	22.86 / 45.72	120 / 240
72″ Tandem, No. 2	400/800	39.6 / 79.2	206 / 412
72″ Tandem, No. 3	400/800	56.4 / 112.8	385 / 770
No. 1 and 2 Planish—Tin Plate	850/1400	138.5 / 228.1	652.79 / 1075.18
No. 3 Planish—Tin Plate	850/1400	153.4 / 252.6	722.9 / 1190.6
No. 4 Planish—Tin Plate	850/1400	153.4 / 252.6	722.9 / 1190.6
Skin Mills—Sheet Gauges	400/800	28.39 / 56.78	149 / 298
No. 1 and 2—2-High	250/750/900	20. 5/61.5/73.8	145 / 435 522
No. 3—2-High	730	38	288.5
30″ x 80″—2-High	730	25.17	198



DEPENDABLE

THE motors for this hot strip finishing mill have been in operation over six years carrying peak loads ranging up to 12,000-amperes (approximately 2½ times normal rated motor current) on the last stands, but no interruptions have occurred due to commutation troubles or flash-overs. There are six 3500-hp, 600 volt, 175/350-rpm finishing stand motors, a 500-hp scale breaker motor and six supporting 2500-kw, 600-volt synchronous motor driven generators. The d-c machines have "Frog-leg" type armature windings providing 100% cross connection.

Other Allis-Chalmers equipment at Inland includes two 1000-kw, 250 volt motor generator sets and switchboard for supplying auxiliary power, 1000-hp wound rotor centrifugal pump motor, main control board, and transformers for mill auxiliaries and lighting. Starting and running oil circuit breakers are of the compact, safety type, Allis-Chalmers Reyrolle metal-clad construction.

Allis-Chalmers engineers have solved many electrical problems introduced by recent developments in operation of rolling mills of all types. You are invited to submit your problems to them for solution.

813

Above: 700 Amp. Reyrolle Metalclad Switchgear
Below: Transformers for mill auxiliary and lighting

ELECTRICAL DIVISION

ALLIS·CHALMERS

MILWAUKEE WISCONSIN

MILLS OF THE INLAND STEEL COMPANY

Built by

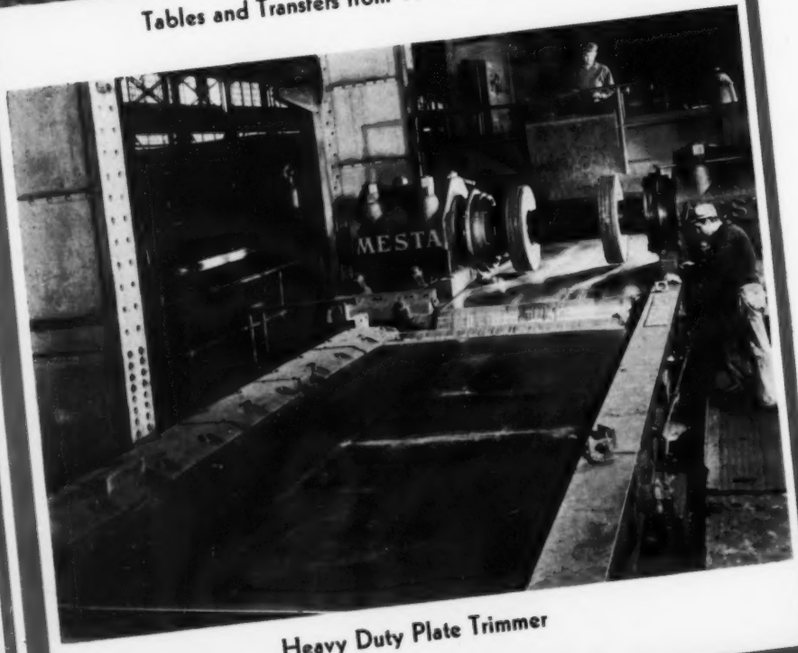
MESTA

46" REVERSING SLABBING-BLOOMING MILL AND EQUIPMENT

79" Four-High Continuous Hot Strip Mill

54" Three-Stand Tandem Cold Mill for Rolling Sheet Stri

Tables and Transfers from 79" Hot Strip Mill



Heavy Duty Plate Trimmer

"INLAND'S CONTINUOUS SHEET-STRIP MILL is the result of long study by leaders in the art of steel making and the design of steel rolling equipment. It is the high point in the perfection of fast, accurate, economical, reliable rolling equipment."

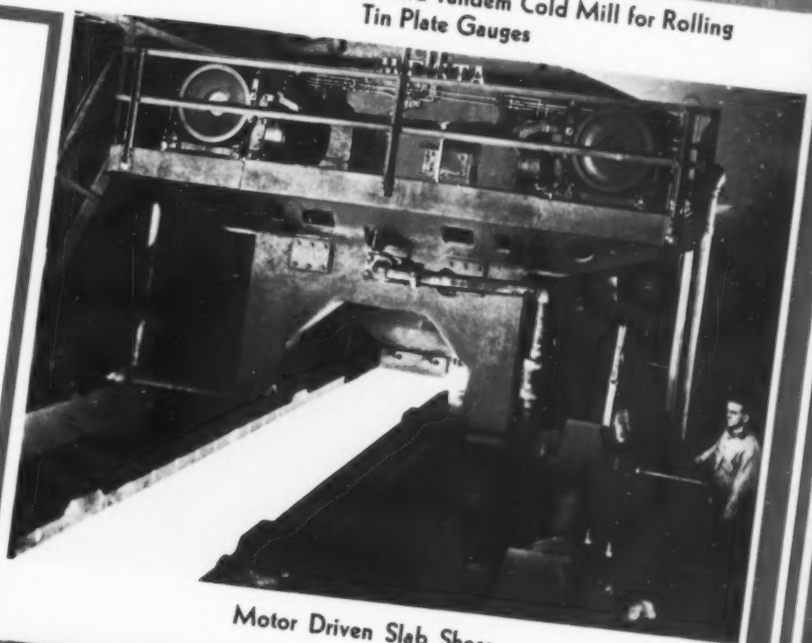
(A paragraph from an advertisement the Inland Steel Company.)

42" Four-High Skin Pass Mill for Cold Strip Steel

42" Four-High Five-Stand Tandem Cold Mill for Rolling Tin Plate Gauges

MESTA MACHINE COMPANY

Designers and Builders of Complete Steel Mill Equipment



Motor Driven Slab Shear

Trimming, Levelling and Shearing Equipment, including Mesta Patented Flying Cold Shear and Patented Feed Reel

MESTA PRODUCTS

Steel Mill Equipment

Bar Mills
Billet Mills
Blooming Mills
Merchant Mills
Piercing Mills
Plate Mills
Rail Mills
Sheet Mills
Slabbing Mills
Strip Mills
Structural Mills
Tin Plate Mills
Tire Mills
Tube Mills
Universal Mills
Wheel Mills
Mill Tables
Manipulators
Bar Shears
Billet Shears
Bloom Shears
Doubling Shears
Hydraulic Shears
Lever Shears
Plate Shears
Squaring Shears
Steam-Hydraulic Shears
Hot Metal Saws
Gear Drives
Transfers
Mesta Patented Feed Reels
Tension Reels
Levellers
Cooling Beds
Pack Annealing Beds
Trimmers and Slitters
Coilers
Electro-Cleaners
Continuous Picklers
Roll Grinders, Roll Lathes

Four-high Continuous Hot Mills
Four-high Continuous Cold Mills
Mesta Patented Flying Shears

Mesta Patented Pickling Machines

Mesta Automatic Plate Valves (Iversen Patents)

Forgings

Large Shafts, Ship Shafts, Billets, Piston Rods, Connecting Rods, Locomotive Axles and General Forgings

Miscellaneous Machinery

Cut and Machine Molded Iron and Steel Gears, Flexible Couplings, Hydraulic and Steam Hydraulic Forging, Bending and Forming Presses, Accumulators, Planers, Draw Cut Shapers, Air Compressors, Large Power Presses, Barometric Condensers, Vacuum Pumps, Annealing Boxes

Rolls and Mill Pinions

Mesta Grain Rolls
Steel and Alloy Steel Rolls
Chilled and Sand Iron Rolls
"Mesta Special" Alloy Steel Rolls
Mesta Hardened Chill Rolls
Mesta Hardened Grain Rolls
Heat Treated Special Alloy Steel Backing Up Rolls
Cut Tooth Mill Pinions
Machine Molded Mill Pinions

Gas and Steam Engines for Blast Furnaces, Rolling Mills and Power Plants

including

Una-Flow Engines (Stumpf Patents)
Piston and Corliss Valve Engines
Reversing Engines
Blowing Engines

Castings

Acid Open Hearth, Carbon and Alloy Steel Castings and Forging Ingots, Air Furnace Iron Castings, Bronze Castings

MESTA MACHINE COMPANY

PITTSBURGH, PA.

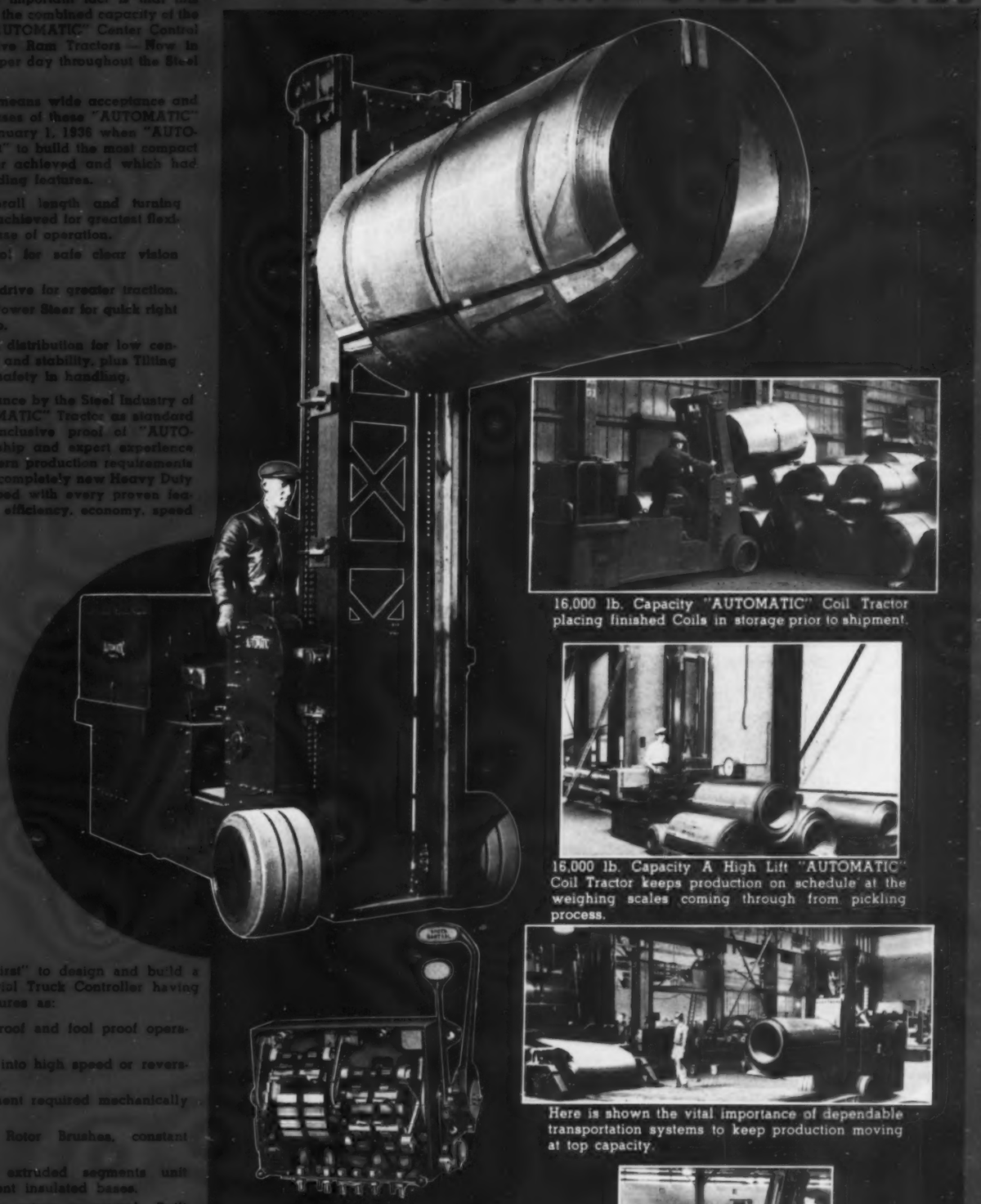
25 MILLION TONS
OF STRIP STEEL COILS

...eel Men! That's plenty of coils per year to ...andle. But the important fact is that this ...gure represents the combined capacity of the ...ntire fleet of "AUTOMATIC" Center Control ...ront Wheel Drive Ram Tractors — Now in ...ervice 24 hours per day throughout the Steel ...dustry.

...his figure also means wide acceptance and ...ontinued purchases of these "AUTOMATIC" ...ractors since January 1, 1936 when "AUTO-...ATIC Was First" to build the most compact ...am Tractor ever achieved and which had ...ll these outstanding features.

- Shortest overall length and turning radius ever achieved for greatest flexibility and ease of operation.
- Center control for safe clear vision driving.
- Front wheel drive for greater traction.
- Rear wheel Power Steer for quick right angle pick up.
- Uniform load distribution for low center of gravity and stability, plus Tilting uprights for safety in handling.

This wide acceptance by the Steel Industry of this type "AUTOMATIC" Tractor as standard equipment is conclusive proof of "AUTOMATIC'S" leadership and expert experience to anticipate modern production requirements in the building of completely new Heavy Duty Equipment equipped with every proven feature—for greatest efficiency, economy, speed and safety.



16,000 lb. Capacity "AUTOMATIC" Coil Tractor placing finished Coils in storage prior to shipment.

16,000 lb. Capacity A High Lift "AUTOMATIC" Coil Tractor keeps production on schedule at the weighing scales coming through from pickling process.

Here is shown the vital importance of dependable transportation systems to keep production moving at top capacity.

"AUTOMATIC" Center Control Ram Tractors now range in capacity from 7,000 to 25,000 lbs. No Coil too large or small to handle efficiently at the lowest cost.

...AUTOMATIC was First" to design and build a ...asically new Industrial Truck Controller having ...uch outstanding features as:

- Absolutely plug proof and fool proof operation.
- No quick plowing into high speed or reversing while in speed.
- No manual adjustment required mechanically or electrically.
- Self-compensating Rotor Brushes, constant tension.
- Commutator type extruded segments unit molded in permanent insulated bases.
- No voltage load on return to neutral. Built in dynamic brakes.

AUTOMATIC TRANSPORTATION COMPANY
47 WEST 87TH STREET CHICAGO, ILL.

If you have steel handling problems, write today for an "AUTOMATIC" Steel Representative to discuss the profitable application of "AUTOMATIC" Trucks, Tractors or Cranes.

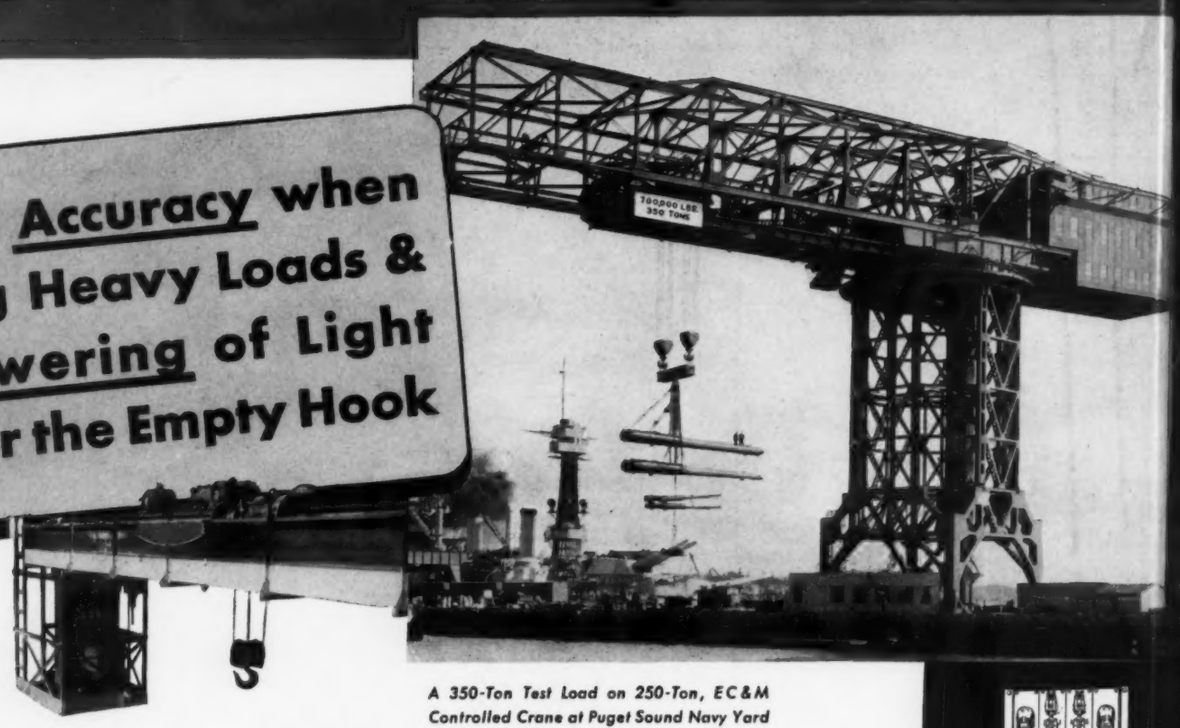
TRADE **AUTOMATIC** MARK
ELECTRIC AND GAS-ELECTRIC
MATERIAL HANDLING EQUIPMENT

PIONEER MANUFACTURERS OF POWER TRUCKS - TRACTORS & CRANES

WELCOME TO CHICAGO . . . ASSOCIATION OF IRON AND STEEL ENGINEERS . . . AT THE HOTEL STEVENS
SEE AUTOMATIC EXHIBIT . . . LOWER LOBBY . . . BOOTHS [illegible]

EC&M Control for Cranes

Includes Accuracy when Spotting Heavy Loads & Fast Lowering of Light Loads or the Empty Hook



A 350-Ton Test Load on 250-Ton, EC&M Controlled Crane at Puget Sound Navy Yard

PERHAPS you've wondered how it is possible to secure accurate control over such a wide range of speed and loads, realizing that heavy loads overhaul and require retarding action to prevent overspeed while light loads have the tendency to lag and must be forced to accelerate in the lowering direction. The answer is simply that EC&M has specialized in crane control equipment for many years and matches this control to the exact requirements of every crane application.

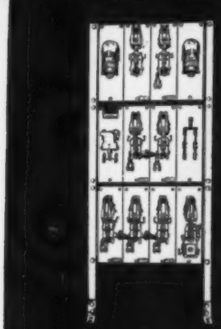
● The recent EC&M Magnetic Hoist Controller with Wright Dynamic Lowering Circuit, for example, makes possible an empty hook speed almost as fast as when lowering full load. This improved controller gives smooth performance over a wide range of loads and speeds —with substantial power savings, as high as 30% compared with previous systems.

● Accurately engineered . . . quick-responding . . . easy operating . . . substantially built with an extra margin of safety and quality in every part, EC&M Control meets every requirement of modern crane performance with efficiency, speed and dependability.

THE ELECTRIC CONTROLLER & MFG. CO. CLEVELAND, OHIO

HEAVY DUTY MOTOR CONTROL FOR CRANES, MILL DRIVES AND MACHINERY • BRAKES • LIMIT STOPS • LIFTING MAGNETS AND AUTOMATIC WELD TIMERS.

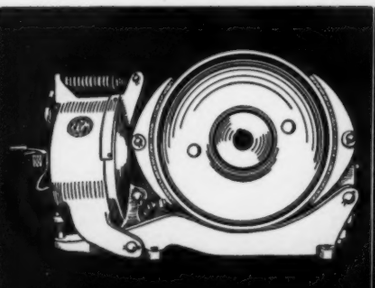
WHEN BUYING CRANES SPECIFY EC&M CONTROL



MAGNETIC CONTR
Bulletin 920

MANUAL CONTRO
Bulletins 960-A, 970,

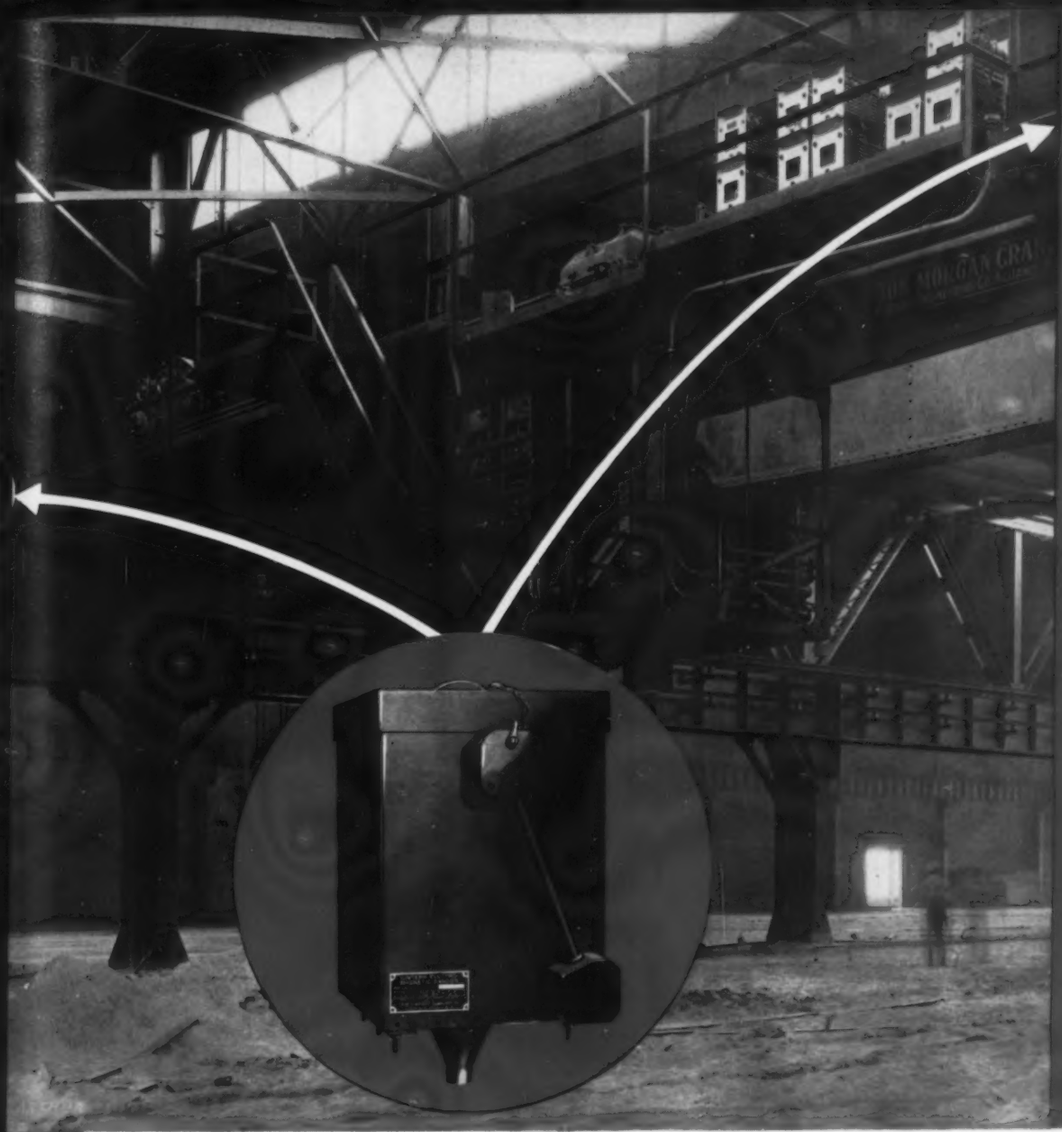
PROTECTIVE PANELS
Bulletin 1021-A



TYPE WB BRAKES
Bulletin 1004-B

LIFTING MAGNETS
Bulletin 900

SAFETY LIMIT STOPS
Bulletin 1038-B



Crane built by
Morgan Engineering Company,
Alliance, Ohio

PROMINENT STEEL COMPANIES PROMOTE SAFETY, EFFECT SAVINGS BY EQUIPPING CRANES WITH

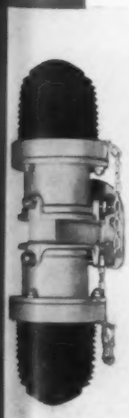
LINTERN SANDERS

On this 5-ton Morgan crane Lintern Sanders were specified by the steel company.

Application of the sanders along the entire runway at intervals provides positive traction for several hours. The spotting of loads is made easy by having equal traction on both rails.

The use of Lintern Sanders also prevents misalignment and consequent loosening of the crane structure, as well as minimizing flange and rail wear.

Similar applications are frequent throughout the Chicago District. Only a small fraction of the crane cost, yet vital to safe, low cost operation are Lintern Sanders.



THE Lintern CORPORATION

7960 LORAIN AVE., CLEVELAND, O.

Lintern Products also include: Electric Heaters for cabs and other industrial purposes, Glowlites, Lintern Lanterns (61 models) and special Lanterns for all kinds of industrial uses.

INLAND'S
TIN HOUSE IS COMPLETELY INSTALLED WITH AETNA-STANDARD STRAIGHT-AWAY TYPE TINNING EQUIPMENT
INSTALLATION OF AETNA-STANDARD TINNING EQUIPMENT VIEW OF CLEANERS AND PILERS
INSTALLATION OF AETNA-STANDARD TINNING EQUIPMENT VIEW OF POOLE FEEDERS
AETNA-STANDARD'S OUTSTANDING RECORD OF TINNING EQUIPMENT BUILT AND SOLD.
POOLE FEEDERS - - 261
DAVIS FEEDERS - - - 291
TIN POTS - - - - 196
TINNING MACHINES - 203
DRIVE HEADS - - 286
CATCHERS - - - 148
CONVEYORS - - - 14
WET WASHERS - - - 140
DRY CLEANERS - - - 156
PILERS - - - - - 36
GRAND TOTAL - 1731

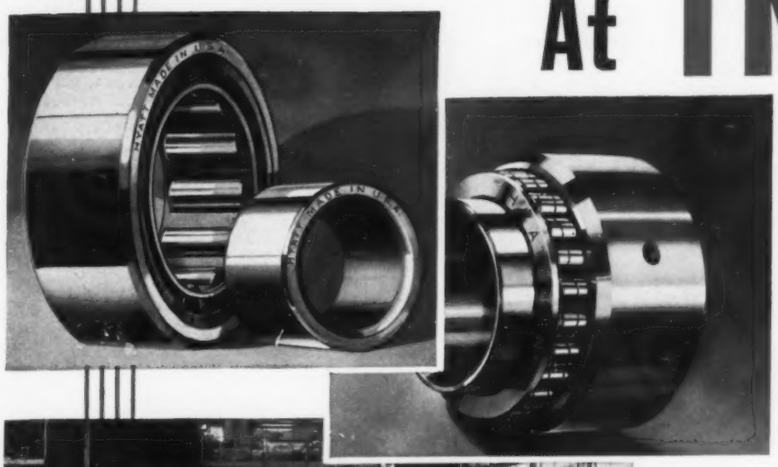
THE AETNA-STANDARD ENGINEERING COMPANY

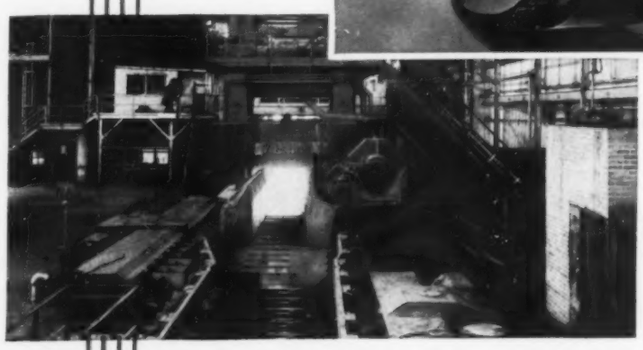
CONSULTANTS • DESIGNERS • BUILDERS

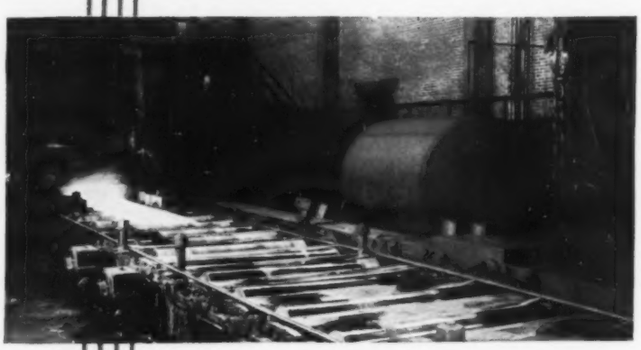
STEEL AND NONFERROUS INDUSTRIES

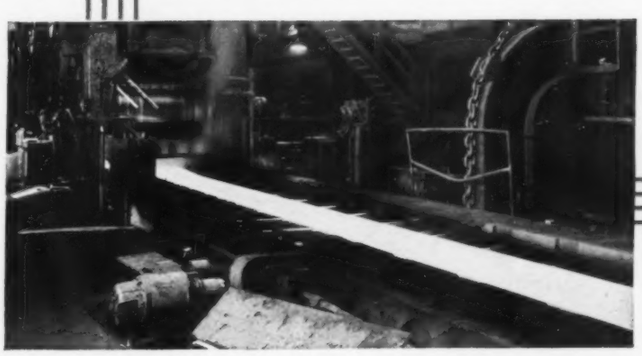
YOUNGSTOWN « OHIO » U. S. A.

At INLAND Too— HYATTS are EVERYWHERE



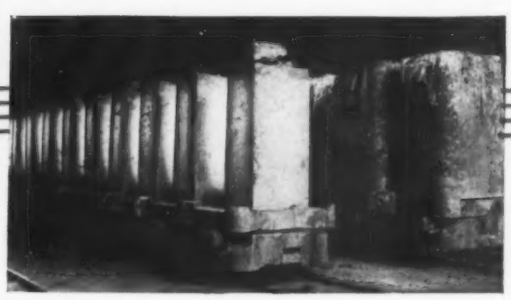






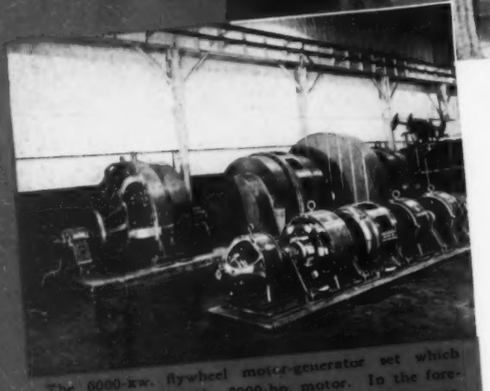
On the A. I. & S. E. Inspection Trip to the Inland Steel Company 76" Continuous Hot Strip Mill you will see Hyattized equipment everywhere. The tables, motors, cranes, cars, and auxiliary equipment in this great mill—all have their quota of dependable Hyatt Roller Bearings.

We need not tell you how Hyatts serve and save—you know from experience with your own operating equipment much of which we venture is similarly Hyatt equipped. Hyatt Bearings Division, General Motors Corporation, Newark, Detroit, San Francisco. Hyatt Roller Bearing Sales Company, Chicago and Pittsburgh.

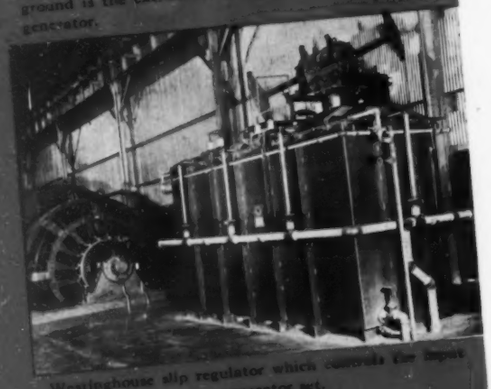


HYATT *Roller Bearings*

This 7000-hp., 50-100-rpm. Westinghouse reversing motor drives the blooming mill rolling slabs for Inland's Indiana Harbor plant.



The 6000-kw. flywheel motor-generator set which supplies power for the 7000-hp. motor. In the foreground is the exciter set for both motor and motor-generator.



Westinghouse slip regulator which controls the input to the flywheel motor-generator set.

SLABS FOR INLAND'S HOT STRIP MILL *are rolled by*

THIS WESTINGHOUSE BLOOMING MILL MOTOR

The demand for slabs for the hot strip mill at Inland Steel Company's Indiana Harbor plant is met adequately by this 7000-hp., 50-100-rpm. reversing Westinghouse motor which drives the 46" blooming mill.

This motor is supplied with power by a 6000-kw. flywheel motor-generator set, with a slip regulator. A Westinghouse switchboard controls both motor and motor-generator set.

Reversing mill motors and control are just part of the complete electrical service which Westinghouse offers steel mills. Electrical equipment of every type is available to meet every problem, large or small. Engineering assistance is at your disposal at all times. Call your nearest sales office. J 93723

Westinghouse Electric, East Pittsburgh, Pa.

Visit us at the
IRON AND STEEL EXPOSITION
Sept. 28—Oct. 1

You are cordially invited to the Westinghouse exhibit (spaces 20 to 26 in the lower lobby) when you visit the convention. In actual operation will be a number of the latest electrical developments for the iron and steel industry. Make our exhibit your headquarters.

HOTEL STEVENS CHICAGO

UNDIVIDED RESPONSIBILITY MULTIPLIES THE VALUE of WESTINGHOUSE SERVICE

FROM POWER SUPPLY TO DRIVEN MACHINE

Specify Westinghouse

You'll see 8 pickle lines on two trips . . . every one lined by Goodrich

ONE of the eight—which you'll see in your trip through Inland—is historic. It is the first successful continuous strip pickling line—lined by Goodrich, working with Inland engineers who pioneered this new idea, now accepted as standard by the entire steel industry. These original Goodrich tanks—now more than four years old—have never leaked, have never required a penny of repair expense, have never caused even a moment's shutdown.

To be certain of such service, it is not enough to order steel-rubber-brick pickling tanks. Only in *Goodrich* tanks will you get Vulcalock permanent adhesion, Triflex lining, patented expansion joints to prevent cracks and—most important of all—the years of Goodrich experience in tank linings.

Goodrich engineers developed the modern rubber-steel-brick tank. There are 26 Goodrich continuous strip pickling lines operating in America, every one of them successful, and four more are being built. And in storage use there are more Goodrich tanks than all other rubber linings combined. All the experience gained in building these tanks, all the engineering knowledge which saves money and prevents trouble, safeguards your investment when you specify Goodrich. The B. F. Goodrich Company, Mechanical Rubber Goods Division, Akron, Ohio. (In Canada: Canadian Goodrich Company, Ltd., Kitchener, Ontario.)

Goodrich

ALL *products problems* IN RUBBER

FROM INGOTS TO F

G-E EQUIPMENT HELPS TO KEEP OP

Another G-E Pioneering Achievement—Variable-voltage Control of Auxiliaries in the 46-inch Blooming Mill

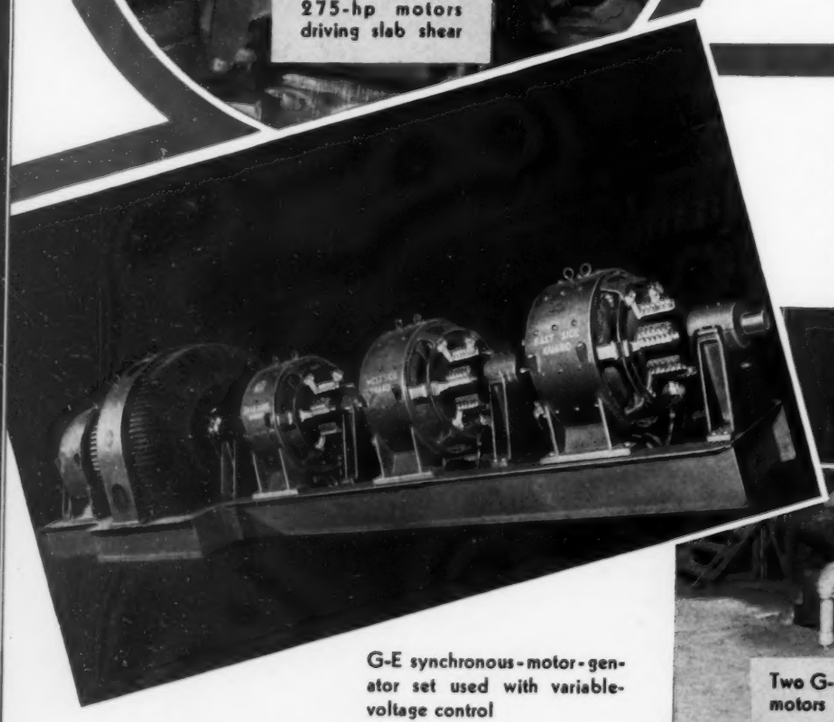
Two G-E Type MD 275-hp motors driving slab shear

HUNDREDS of motors, large and small—control of every description—metal-clad switchgear—such is the G-E equipment you will find in the blooming mill and in the hot- and cold-strip mills in the Indiana Harbor plant of the Inland Steel Company.

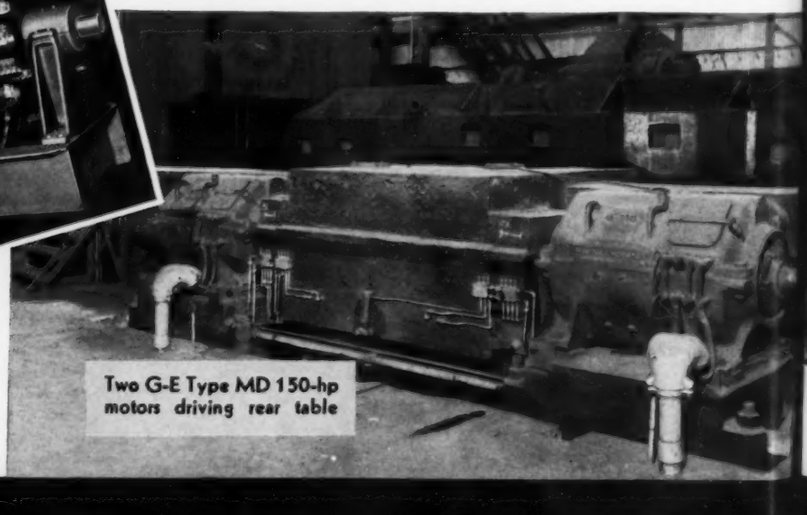
Skillfully designed and sturdily constructed, this equipment is an outstanding example of G-E dependability. In applications such as the variable-voltage control of the blooming-mill auxiliaries, it represents the latest developments in electric equipment for steel mills.

Let G-E engineers help you with your problems as they have helped with Inland's. Whether you are planning the largest mill yet built or a moderate-sized one, they will be glad to study your particular requirements and work with you until the equipment is installed and running. Their wide experience assures satisfaction. For further information, call the nearest G-E representative. General Electric, Schenectady, N. Y.

The G-E mill-type motors shown here are controlled by a new system—variable-voltage control. This system was first adopted by Inland. All subsequent reversing-slabbing mills and blooming mills built or planned have called for it. It makes possible much faster, more flexible operation. It saves wear and tear on both electric and mechanical equipment. It reduces control maintenance expense to practically nothing. Its successful adaptation to steel-mill service is another outstanding pioneering achievement of G-E engineers.



G-E synchronous-motor-generator set used with variable-voltage control



Two G-E Type MD 150-hp motors driving rear table

The equi

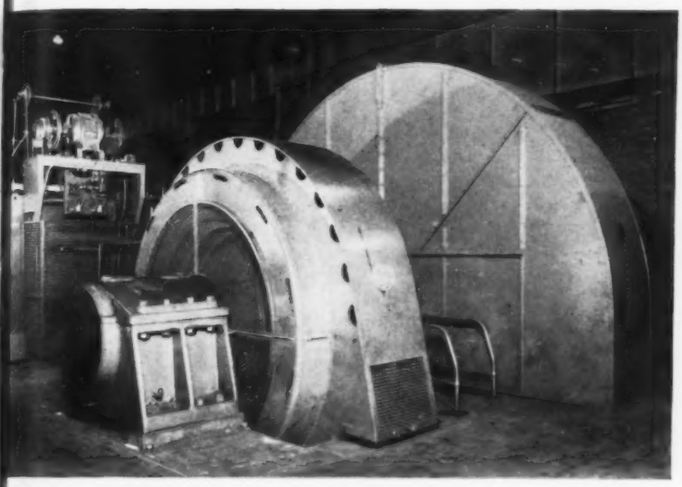
Control cold-strip equipme

GENERAL

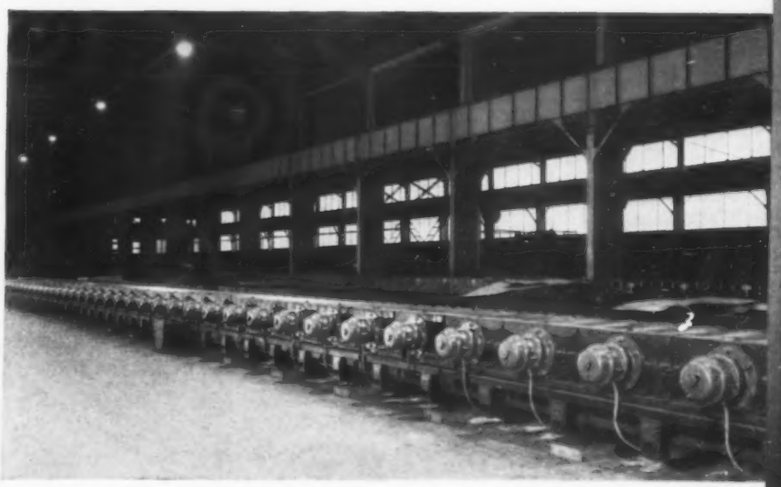
FINISHED STRIP

OPERATIONS CONTINUOUS AT INLAND

First and Last, G-E Motors in the 76-inch Hot-strip Mill Aid in the Rolling and Handling of Steel



G-E 3000-hp induction motor driving roughing stand Number 1



Some of the 373 G-E totally enclosed induction motors driving the runout tables at the end of the hot-strip mill

The Inland cold-strip mills are G-E equipped throughout

Control board in the 72-inch cold-strip mill—one of many G-E equipments of this type at Inland

More than any other type of mill, cold-strip mills require electric equipment that is closely co-ordinated with the mechanical equipment. The control must meet special requirements, yet be flexible enough to be adapted readily to new conditions as they arise.

The electric manufacturer who would furnish a successful cold-strip-mill installation must have wide experience, the ability to furnish complete equipment, and be ready to assume undivided responsibility. It is significant, that General Electric designed and built practically all the electric equipment for Inland's cold-strip mills. Once again, the tougher problems were taken to General Electric for solution.

Looking Ahead—Metal-clad Switchgear for the New Hot-strip Mill

Modern G-E 6600-volt metal-clad switchgear, with FKR-255C oil-blast breakers of 500,000-kva interrupting capacity. This switchgear is of the type that is being built for the new hot-strip mill

ELECTRIC

011-260

STEEL MILL "TONNAGE" DEMANDS RUGGED, MASSIVE CONVEYORS

Live Roller Feed Table handling steel packs.

A Nation-wide Service in Conveyor Engineering

STANDARD CONVEYORS

Gravity lines feeding steel packs to live roller conveyor.

STANDARD CONVEYORS

Roller conveyor delivering coils to pickling storage.

The movement of heavy, concentrated loads of sheets, packs, or bars places heavy burdens on conv equipment. Sturdy, rugged, massively built conv are needed to carry these loads at the high s required to keep handling costs at the minimum.

Standard has built dependable conveyors for steel for more than thirty years . . . Why not have a Stan engineer check the handling needs of your m there's no obligation. His experience will aid to plan efficient, economical handling. Call Standard office near you or write direct for bulletin "Conveyors by Standard for Steel Mill and Foundr

You are invited to visit our booth No. 60 at the Iron & Steel Convention.

STANDARD CONVEYOR COMPANY.

GENERAL OFFICES: NORTH ST. PAUL MIN

Holophane

STEEL-CLAD

Standard HI-BAY

Lighting Equipment

for Steel Mills

- The sincerest form of endorsement for Holophane Standard HI-BAY Lighting is the fact that an imposing number of the leading steel companies have successfully installed these units in their plants.

- Holophane engineers ---- authorities in lighting since 1898 ---- offer intelligent competent counsel on all industrial illumination problems. Write for data.

- **HOLOPHANE COMPANY, Inc.**

242 MADISON AVENUE, NEW YORK

for **EFFICIENCY-PERMANENCE-SAFETY**

Inland
"Tool Steel" Gears – Crane Wheels – Rolls

AS USUAL: The up-to-date mill, bought with an eye on future maintenance has—

"Tool Steel" gears and wheels specified to all 4 of the makers of its cranes.

"Tool Steel" rolls on its levellers.

This is the usual *quality* specification.

INLAND *KNOWS*: They have tested "Tool Steel" against all kinds of competition and for many years bought "Tool Steel" replacement parts for their cranes, mills and miscellaneous work almost daily.

(This advertisement used with the permission of Inland Steel Co.)

NEARLY TWO MILLION TONS ON TIMKEN BEARINGS

The Inland Steel Company's 76" 4-high continuous hot strip mill affords another striking example of the endurance and economy of TIMKEN Roll Neck Bearings.

Since the mill went into operation in 1932 it has rolled close to 2,000,000 tons and the bearings are still in good condition. It is difficult—if not impossible—to accurately estimate the ultimate life of these bearings, but in view of the phenomenal performance of TIMKEN Bearings in other mills, a further life expectancy of many thousands of tons is indicated. There are 9 stands in the mill proper—3 roughing stands and 6 finishing stands. TIMKEN Bearings are used on all back-up and work rolls of these stands and also on the back-up rolls of a 96" 4-high spreader stand where the slabs are cross-rolled.

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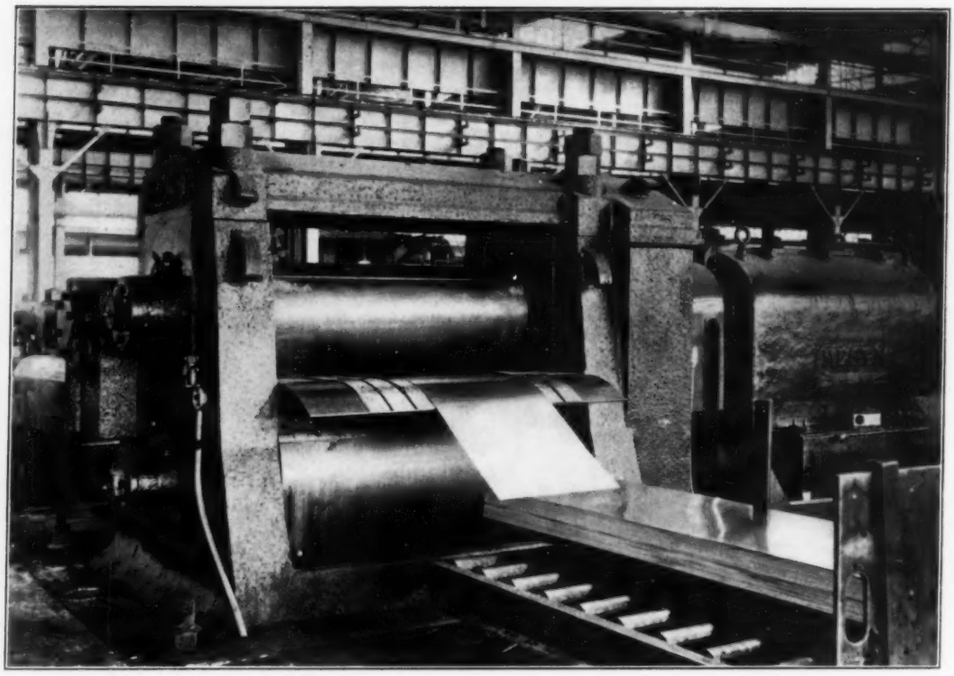

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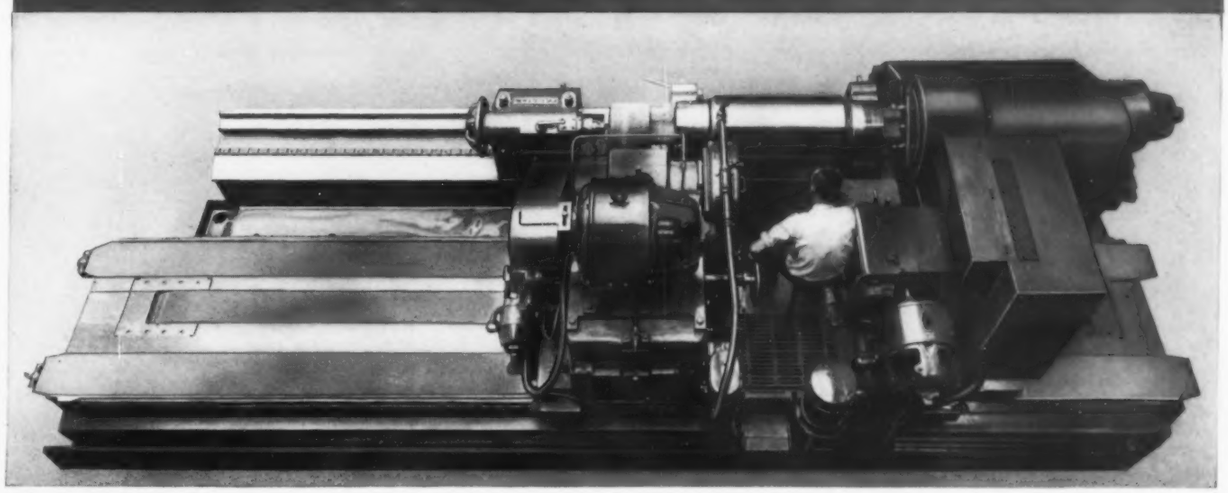

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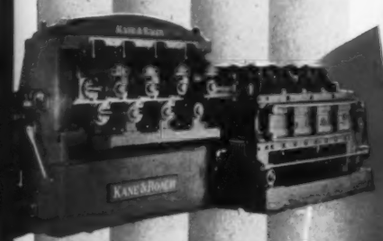

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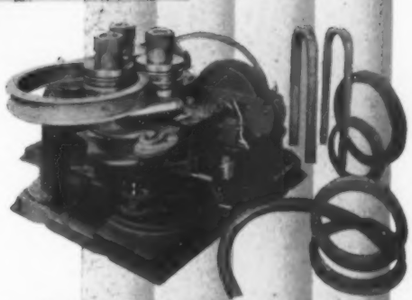

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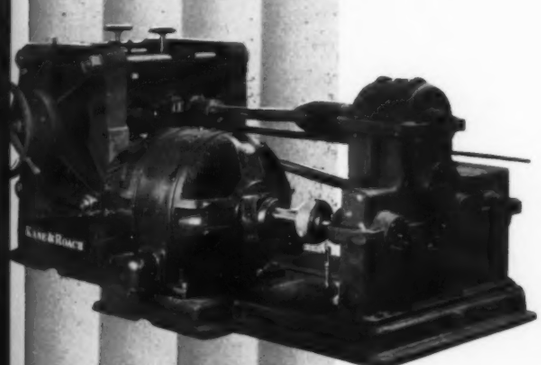

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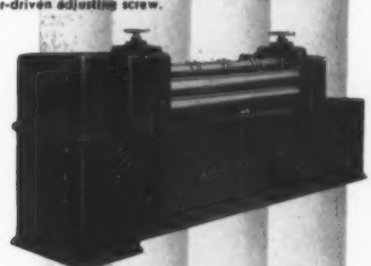

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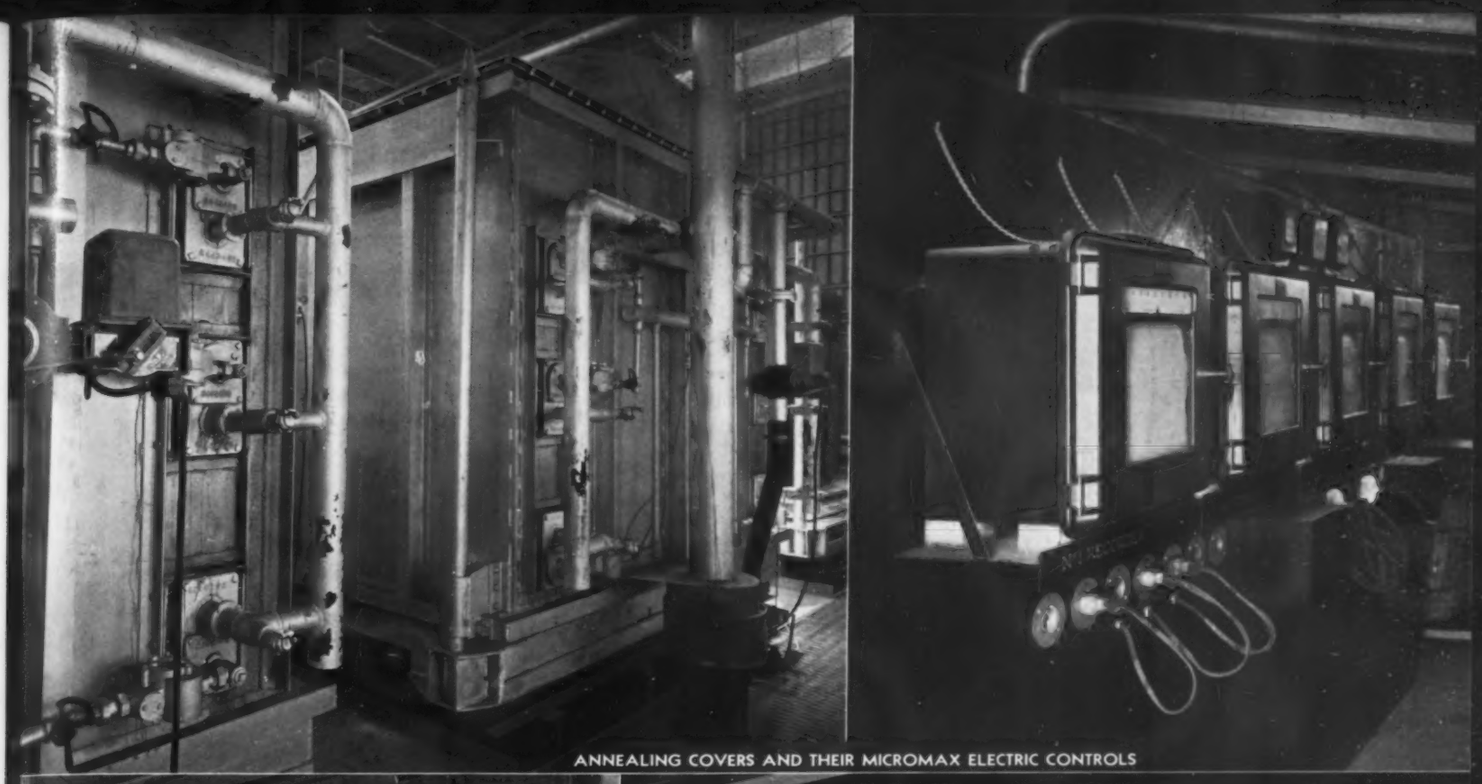

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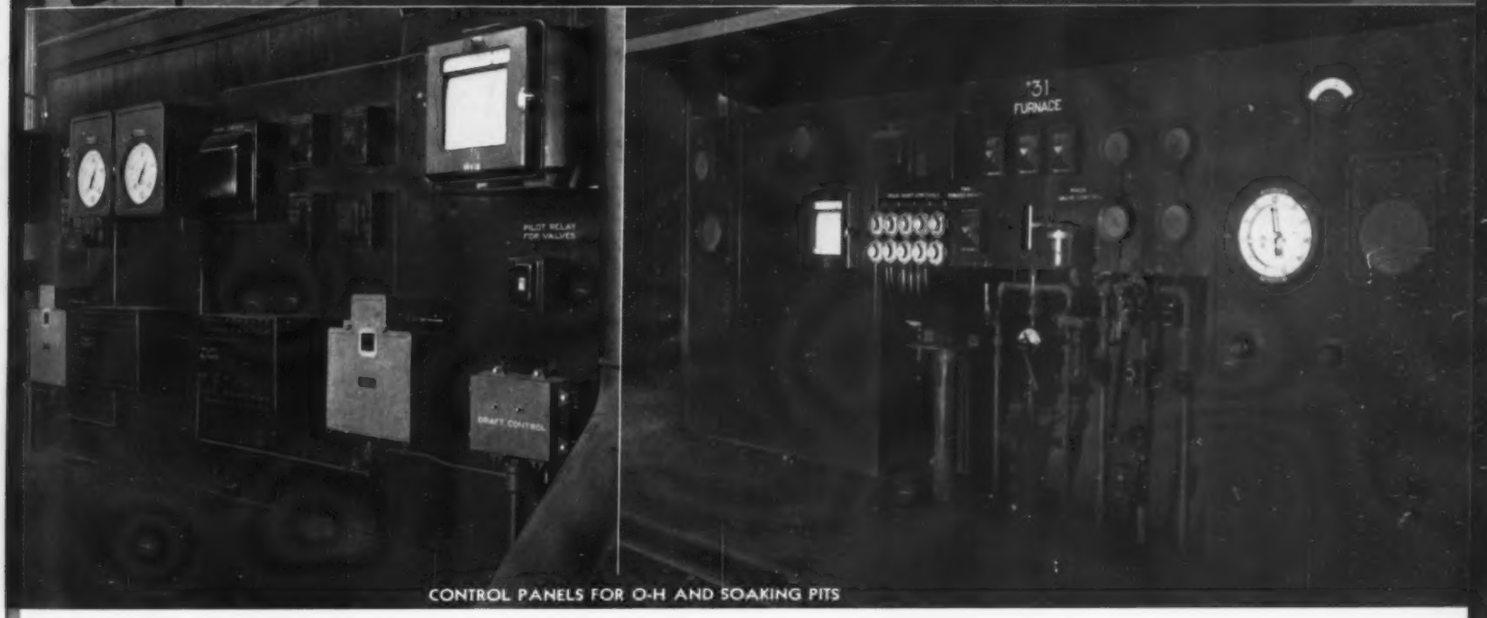

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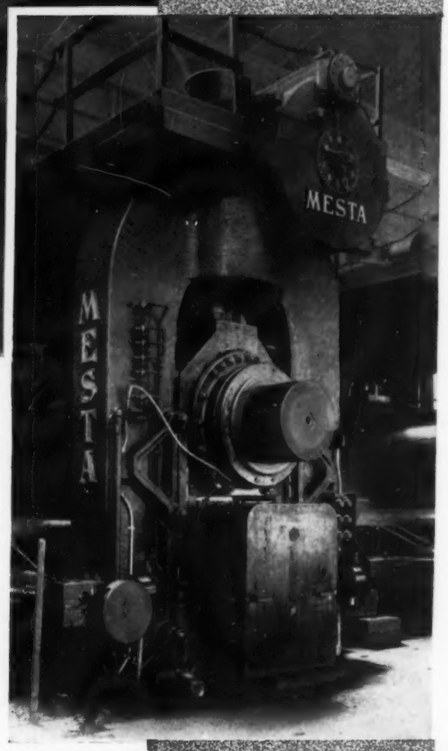

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CENTRALIZED SYSTEMS OF LUBRICATION

LUBRICATING OIL FLOODED ROLL NECK BEARINGS

By H. H. WOOD, Engineer
Morgan Construction Company
PITTSBURGH, PA.

Abstract of paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ THE Morgoil Bearing is a totally enclosed oil film bearing whose inner and outer races are separated by an unbroken oil film. It was developed primarily for use on roll necks in rolling mills where, due to its high load carrying capacity and freedom from fatigue and wear, it has quickly made a place for itself, not only

H. H. WOOD

in the ferrous and non-ferrous mills in this country, but in foreign countries as well.

The bearing parts proper consist of the roll neck sleeve or inner race with taper bore and cylindrical outside surface and with integral thrust flange. The sleeve rotates with the roll neck inside a steel bushing whose inner surface is coated with a comparatively thin lining of special bearing metal and the sleeve and bushing are separated by the oil film. The thrust bearing, which is double acting, consists of the thrust flange on the sleeve, or the rotating element, and two stationary steel thrust shoes with the surfaces adjacent to the flange of the sleeve also coated with a comparatively thin section of the same special bearing metal used in the bushing. The taper bore roll neck sleeve, whose taper is non-locking, is held in position on the roll neck by a lock nut threaded over a split threaded ring which seats in a wide groove in the roll neck.

Oil is retained in the bearing by seals of a conventional type at both inboard and outboard ends. The inboard seal is a double seal whose element toward the roll barrel is used to prevent entrance of foreign matter to the bearings. As further protection, a water guard seal is applied against the end of the roll barrel.

The Morgoil Bearing has a very low coefficient of friction in the range of .0015 to .003, which is on a par with the coefficient of friction of anti-friction bearings, oil and grease lubricated. It is obvious that with almost perfect surface of journal and sleeve that the oil film can be extremely thin and still prevent metal to metal contact, and this results in uniformity of load carrying capacity throughout the speed range of the mill.

The oil enters the Morgoil Bearing through a drilled hole parallel to the axis of the roll and at any convenient location in the chock. The drilled hole meets two annular grooves in the bore of the chock extending from slightly above the horizontal center line of a top bearing around the bottom of the chock and up to a point above the center line on the opposite side of the bore. In bottom bearings the annular grooves are reversed and are at the top of the chock. From these grooves the oil is delivered through holes in the side of the bushing through which the oil flows to oil pockets in the bore of the bushing, one on each side centered on the horizontal center line. From these oil pockets, which are kept full of oil under slight pressure, the bearing receives its oil supply. As there is an oil pocket on each side, it does not make any difference which way the bearing runs and it is therefore applicable to reversing mills.

No effort is made to trap the oil in the bearing parts proper. The end leakage from the inboard end drains to the inboard oil sump in the chock. The end leakage from the outboard end flows into and lubricates the double acting thrust bearing. A series of drilled holes at an angle in the thrust flange carries the required amount of oil to the outboard element of the double acting thrust bearing and from both sides of the thrust bearing the oil drains to the outboard oil sump. The inboard and outboard oil sumps are connected by a large horizontal drilled drain and from this drain which reaches the outboard surface of the chock, the oil flows to the flexible drain hose and so through the drain lines to the receiving tank of the circulating system.

The lubricant supplied to Morgoil Roll Neck Bearings must be a high grade straight mineral oil free from acid and other impurities and must have a high resistance to oxidation and to the formation of sludge when subjected to hard service. It must separate rapidly from water and other liquid impurities and must, therefore, be a type of oil which shows an excellent demulsibility test.

It is of great importance that the oil be of a type which has a high viscosity index. The viscosity of the oil to be used is determined by the minimum speed of operation of the rolls in RPM and also by consideration of the unit loading on the projected area of the bearing. A condition of maximum load, minimum speed and minimum viscosity of oil that will support the load makes for lowest possible coefficient of friction.

The quantity of oil needed to lubricate a Morgoil Bearing is based on complete replacement of the oil film in a specified number of revolutions. Therefore, a given size bearing operating at high speed needs more oil than the same size bearing at low speed. Oil factors have been developed for each size bearing, which, when

multiplied by maximum RPM of the oil to which the bearing is applied, gives the maximum gallons per minute of oil required. The use of the oil factors always results in an over-supply of oil or, what is termed "flood lubrication".

On each side of the mill, that is on the drive side and the operating side, there is a flexible supply riser and a drain riser. From the supply riser two flexible supply lines take the oil to the lubricant entrance in the top and bottom bearings. These lines, of course, are under pressure. From the bottom of each bearing at the drain opening, a flexible drain line takes the oil from the bearing to the drain riser. At the top of the supply riser is a pressure gauge which enables the operator to know definitely that the oil is being supplied to the bearings at the correct pressure. Also, at the top of the supply riser there is a pressure switch with low limit alarm contact and a red light. This pressure switch is set at a pressure below the normal operating pressure at the particular mill stand and if the pressure drops below standard the red light lights, signaling the operator and usually the red light circuit is tied in to actuate a siren.

Sufficient pressure is carried on the riser at the mill stand to cause the required gallons per minute of oil to flow through the bearings when the mill is operating at absolute top speed. At any speed below the maximum, the bearing acts somewhat as a measuring valve to the extent that it actually takes less oil when running at slower speeds. Normally, Morgoil Bearings require from 5 to 15 pounds pressure at the supply riser.

In general, the lubricating system equipment consists of a single or double compartment receiving tank in the oil cellar from which two rotary pumps, motor driven, take the oil through the floating suctions. Two pumps are installed, either of which is adequate to supply the maximum amount of lubricant required. The pump delivers one hundred percent of the oil through filters of the mesh type or of the rotary self-cleaning type, and from the filters the oil goes into the main supply line and so to the mill. Beyond the filter there is a lead from the main supply line to a pressure tank. Compressed air is introduced to the top of the pressure tank so that the tank is normally about one-half or two-thirds full of oil. A pipe leads off horizontally from a location near the top of the pressure tank and on the pipe and connected into it are three pressure switches. Two pressure switches are for the purpose of starting and stopping the service pump and the spare pump and are adjustable throughout a given pressure range. The third adjustable pressure switch is used to ring an alarm gong if, for any reason, the pressure on the main supply line is below standard.

As the pump delivers a definite number of gallons per minute and as the demand at the mill varies with the changes in speed and with starting and stopping, a relief valve is provided in the main supply line in the vivinity of the pressure tank branch and is adjusted to give the desired main supply line pressure.

In a continuous mill installation, due to the variation in speeds through the mill, the GPM oil requirements for each set of four Morgoil Bearings in each stand is different. It is usual, therefore, on the branch from the main supply going to each individual stand to install a pressure reducing and regulating valve of the diaphragm type and these are adjusted to give correct riser pressure, which results in correct oil flow for the maximum operating speed of the stand in question.

In large and important installations using high viscosity oil, it is good practice to install a centrifuge so that if impurities do not settle in the resting compartment even when raising the temperature of the oil by the use of heating coils, it can be centrifuged and purified.

The following are requirements which merit consideration:

1. A high quality straight mineral oil meeting standard Morgoil specifications.
2. An adequately proportioned lubrication system of the full filtration type, automatic in operation with standard pressure and temperature controls. This is protected by standard alarm signal devices.
3. Thorough cleaning out of the lubrication system before introducing the lubricating oil at the time of starting the installation.
4. Maintaining an adequate amount of oil in the system at all times during operation so that there will be a proper relation between the amount of oil being pumped and the amount of oil in the receiving tank.
5. Periodic tests of the oil in the system for viscosity, neutralization value and contamination for proper operating control. If the operating company is not equipped for such tests, the supplier of the oil in most cases is glad to make them.

STEAM POWER DEVELOPMENTS

By CHARLES W. E. CLARKE
Consulting Engineer
United Engineers and Constructors, Inc.
PHILADELPHIA, PA.

Abstract of paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ IN the past ten years there has been a tremendous development in the power plant field. Boiler pressures, steam temperatures and sizes of boilers and generating units have increased enormously. Pressures in the last twenty years have increased in general from about 250 lbs. to 1,400 lbs. Steam temperatures during a like period have increased from about 650° to 950° total final temperature. In 1915 the boiler with a steaming capacity of 100,000 lbs. per hour would have been considered a very large unit. Today boilers of 750,000 to 1,000,000 lbs. per hour capacity are not rare and capacities as high as a million and a quarter pounds per hour have actually been obtained from existing units.

In the case of turbines, twenty years ago a 15,000 kw. unit was considered a large unit. By 1920 this had been increased to about 50,000 kw. and today, units of 100,000 kw. are in general use, while there are several

units in actual operation of from 160,000 kw. to over 200,000 kw. capacity.

In general the larger the steaming or generating units which are installed, the cheaper the installation becomes. This has been one of the principal incentives to the utility industry to use larger units. Generating units operating at 3,600 rpm. are being built as large as 50,000 kw. and manufacturers are at present giving consideration to going as high as 75,000 kw. at 3,600 rpm. This applies particularly to complete condensing units.

Coincident with these changes there has been a material increase in the overall efficiency of the generating plant. With the steam cycle of today it is

CHARLES W. E. CLARKE

entirely feasible to obtain overall plant thermal efficiencies of about 30%. Ten years ago 23% would have been considered excellent performance.

These tremendous advances have been made possible by several factors:

1. The development of chrome, nickle and molybdenum alloys have allowed a construction (in machines, piping connections and other pressure parts of the generating plant) which copes with the increased stresses and which permits safe use of the high pressures and temperatures which have developed.
2. Improvement in welding and manufacturing processes. The highly developed welding art has been extremely effective in allowing efficient production not only of boiler parts but of piping systems also, allowing the welding-in of valves and obviating the need for flanged joints which under the higher temperatures are apt to require considerable maintenance due to the creep stresses in the joint bolting material.
3. Better knowledge of physical properties of steam.

Meanwhile steaming equipment development as sponsored by the various manufacturers, progressed along radically variant lines. Many of the boilers being installed today consist in general of a large amount of radiant water-wall surface combined with a relatively small amount of boiler convection surface and are usually attended by extremely large economizers and relatively large air heaters.

In order to keep step with the large steam-generating units it has been necessary that the firing equipment be developed simultaneously. In general most of the larger boilers are now pulverized fuel fired. Both wet and dry bottoms are being used. The continuous-tap wet bottom is gradually superseding the older slag-tap or intermittent type of wet bottom. Pulverized fuel firing is particularly interesting to users who have a multiplicity of fuels available. In the steel industry, for instance, coal, blast-furnace gas, coke-oven gas and natural gas are all available, sometimes all four in one location. It is not at all difficult to properly design an installation so that any of these fuels can be satisfactorily burned in turn or several of them in combination. In many of the utility installations we frequently find coal, natural gas and oil available and in such case, the same is true.

When pulverized fuel is used in populous communities it is becoming more and more necessary to use some method of arresting the fly ash which results. There are several systems in use for this purpose the two principal ones being the electrostatic type precipitator, and the cyclone type.

The draft system, combustion control, fans, degree of superheat, auxiliaries—all have been influenced by the fundamental changes in pressures and temperatures. There has been extensive development of combustion control systems, permitting very precise control of all the various elements of operation, particularly those pertaining to the boiler room. There is a development in process, advantageous in some locations, for combining forced and induced draft fans in one casing, with a resulting saving in cost but with some sacrifice of flexibility. With the higher steam temperatures and their resulting effect upon turbine operation it has become extremely important that the temperature of the superheated steam be carefully controlled and this is in general being accomplished by by-passes in the boiler gas flow system which allow such specified amounts of hot gases to flow over the superheating surface as may be required by the load conditions. Auxiliary power, particularly for the feed pumps, becomes a very important factor. All auxiliaries should be motor-driven, but since in some cases the boiler-feed units require some 1,000 to 2,000 hp. for driving, it is often necessary that they be steam-driven.

Present-day heat cycles are for the most part of the regenerative type and in ordinary installations it is entirely feasible and is good practice to bleed the turbines at from three to five points and thereby pass as much as 30% of the total throttle steam flow through the turbine into the feed water cycle. These regenerative heat cycles are composed of two classes:

1. With contact type of open heaters.
2. With heat exchangers or so-called pressure heaters.

It is usual in the regenerative heating cycle to compensate for any water loss in the plant system by installing an evaporator in the heat cycle to supply the necessary make-up.

It is sometimes necessary, particularly in industrial plants where there is no condensate available for feed water use, to operate the boilers with 100% make-up. Treatment of feed water has advanced to such a point

that this is entirely possible and there are many relatively high-pressure plants operating at large capacities with 100% make-up for feed water. This would have been considered more or less impossible even five years ago.

Perhaps one of the most striking results of all is the enormous increase in so-called topping units in both industrial and public utility plants. A topping unit is usually understood to consist of a unit taking steam at relatively high inlet pressure and exhausting either into the lower pressure turbine inlet or into steam mains for auxiliary plant use at relatively low pressures, usually in the neighborhood of 200 lbs. One particular advantage in this type of unit is that it does allow the rehabilitation of old generating plants. Where existing generating equipment is reliable, it is possible by the use of a topping unit to bring the overall efficiency of the rehabilitated plant up to date.

Another important development is the use of hydrogen as the cooling medium for the generator. A very large proportion of present day machines are, or will be, hydrogen cooled.

The general trend in condensers is for completely welded shells. In many cases these are being welded directly to the turbine exhaust nozzle which is of fabricated steel. In cases where external pumping head is low and where water supply is not restricted, the single-pass condenser will be found advantageous. In other cases it may be advisable to use either two- or three-pass condensers depending on amount of water available. In general air-removal apparatus consists of steam jets usually provided with proper inter- and after-coolers.

CONTROL SYSTEMS FOR SOAKING PITS

By A. E. KROGH
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Brown Instrument Co.
PHILADELPHIA, PA.

Abstract of paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ THE process of reheating ingots preparatory to rolling is being closely scrutinized nowadays for possible improvement in fuel economy, metallic loss, even heating, increased production, and general all-around efficiency. A number of new pit designs have been made, with the designers outdoing one another in showing increased efficiencies. The results have been highly gratifying, and are, in fact, revolutionizing practices in many mills. The soaking pit is graduating into a heat treating furnace. While various designs of pits differ in many respects, there is universal agreement that a complete automatic control system is a requisite of any modern pit. It will be the purpose of the paper to describe what such complete control systems accomplish for the user.

The individual parts of control systems must necessarily be adapted to meet conditions for each job, but in each case it is important to remember that if automatic control is to be attempted it should be complete and unified, with each part working in cooperation with all others to achieve the desired results. For instance, the best conceivable pit pressure control could not accomplish the desired ends if the furnace were being fired with a "feast and famine" type of temperature controller, nor can satisfactory economy be secured by a temperature controller if the pressure of the fuel ahead of the valve is allowed to fluctuate, etc.

The difference in cost between a soaking pit with miscellaneous controls and a pit with a completely

A. E. KROGH

engineered instrument control system is not great in dollars and less in terms of per cent, but the difference in service and satisfaction is great measured in both terms.

Agreement seems to be general that complete control of soaking pits involves the following:

1. Control and indication of pit pressure or draft.
2. Control of atmosphere or fuel-air ratio. This frequently also involves control of fuel and air pressures ahead of the controlling valves and control of air preheat temperatures. Preferred forms record and integrate fuel flow and record waste gas analysis.
3. Control of temperature.
4. Control of reversal periods for regenerative pits.
5. Control of fuel limit.
6. Shut-off control of fuel and air when pit is opened.

A number of other controlling equipments could be included in this line-up, but diminishing return can generally be expected as additional niceties are introduced.

The desirability of pit pressure or draft control need hardly be stressed. It saves fuel by preventing air infiltration, and tends to maintain the furnace temperature more constant. The control equipment must be very sensitive, independent of temperature fluctuations, anti-hunting, and of a quick-acting type in order to respond quickly and correctly to the many upsets that occur while the pit is being charged and drawn.

A number of installations, involving a bank of pits, have been made wherein the pressure at the base of the stack was controlled for all pits. This can be successfully accomplished only when proper means are taken to assure that the damper is not made to hunt in any position.

Control of pit atmosphere is one of the chief contributing factors to the remarkable evenness of heating and reduction of metallic loss which has resulted from these new pit designs. By keeping the atmosphere surrounding the steel at desired values, washing of the ingots can practically be eliminated, especially when atmosphere control is combined with temperature control. Here again it is important that the sensitivity of the control system be satisfactory, both for the heating and the soaking periods. The radically differing amounts of fuel required in the two instances require a control system especially adapted to avoid hunting at all rates of fuel flow.

In selecting temperature control equipment for soaking pits, the first problem is to determine a suitable point of temperature measurement. In many of the older designs of regenerative soaking pits, it was practically impossible to find a location for a temperature measuring device which would give information indicative of the actual temperatures of the ingots. In both old and new pits, the use of radiation pyrometers sighted directly upon the ingots has been discouraging due to the flame conditions within the pit. Generally, temperature measurement must be confined to a temperature sensitive device, such as a radiation pyrometer or a thermocouple, measuring the temperature within a refractory tube built into the wall of the pit. Excellent results have also been secured by installing thermocouples in the outlet flues and controlling these to a given value found to correspond to desirable conditions.

The control of reversal periods on regenerative soaking pits has long been practiced at some plants with excellent results. Generally the reversal is determined by the lapse of definite time intervals which may, in some instances, be made to differ for the two sides of a pit. Since the temperature controller will adjust the fuel to maintain a given temperature in the pit, differing consumptions of fuel will be required, depending upon which checker is used for preheating the air, and a recording flow meter, which is a part of the atmosphere control system or of the fuel limit control, will clearly indicate the need for changes in time periods between the two checkers.

Modern pits are being equipped with control instruments that definitely limit the rate of fuel input. The old days of heating ingots in "a hole in the ground" by simply sticking a burner in and "giving her all she could take" are gone. The resultant saving in fuel easily pays for the initial investment in a short period of time. The additional saving in avoiding ingot washing is pure profit.

An incidental but important feature of modern control systems for soaking pits is the use of a safety shut-off system which automatically shuts off fuel and air to the burners as soon as the cover is lifted, preparatory to opening the pit.

On paper, these controls appear somewhat formidable and, indeed, they can be if each strives to do its job regardless of the others, but when all are combined and engineered into a unified whole, properly tuned in for the particular furnace, the result will be efficiency and satisfaction of a high order. On such systems, it matters little what the operating medium may be—whether electric, hydraulic, or pneumatic. Each type is good and has its place.

DEVELOPMENT OF COVERED ELECTRODE ARC WELDING

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Abstract of paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ WITHIN relatively recent years the use of covered electrodes in this country has taken a predominant position, and they are now sold in large tonnage quantities. In fact, covered electrodes are rapidly superseding bare electrodes. However, covered electrodes were first developed in England and marketed in the early 1900's. These rods were introduced into the United States, but the cost plus duty restricted their use and adoption on anything but a small scale.

About 1918 one or two large companies in this country began the experimental development of covered

A. M. CANDY

rods for their own use exclusively. Several other companies followed suit, but it was not until about ten years later than any companies began to manufacture covered rods for commercial sale.

During the early stages of covered rod development and manufacture the cost of production was relatively high, and as a result the selling price showed a large spread above bare rod prices. However, by improving

production methods and by the substitution of high speed machines for production the cost of covered rods has been reduced to the previous prices obtained for bare rods.

The manufacture of covered rods is not as simple as some persons might think. Between the various analyses of steels and non-ferrous base rods to be used and the almost unlimited combinations of natural materials that can be used in the coatings or coverings the field of the research chemist and metallurgist becomes almost staggering.

There are a large number of objectives to be obtained by means of rod coverings among which are the following. Increase the melting rate of the rod and base metal. Make the arc more stable. Minimize spatter loss of molten metal. Improve physical properties of weld metal. Make equally good welds with positive or negative polarity. As a result of these developments, welds having physical properties equal to or better than the base metal can be made in any of the steels including all alloys and in the non-ferrous field including aluminum, copper and others.

Just to give an idea of the improvement made in mild steel welding we give the following table, which shows the comparative results of making a weld with bare wire, and a suitably covered rod.

Property	Bare Rod	Covered Rod
Ultimate Tensile Strength	50,000	65,000
Yield Point		51,000
% Elongation in 2"	4—10%	25—30%
Brinnell Hardness	185	160
Impact (Izod)	5—10	60
Fatigue Limit	10,000-12,000	30,000-32,000
Specific Gravity	7—7.5	7.85

As a result of improved weld properties the field of application of electric welding has been expanded vastly. The cost of producing many structures has been decreased. Furthermore many structures can now be welded with safety and assurance so that they they will not fail in service where they are subject to shocks, alternating loadings or alternating pressures or temperatures.

One of the largest presses ever produced is entirely welded. The press is approximately 29 ft. long, 28 ft. high and 6 ft. wide, and weighs approximately 750,000 lbs. Covered electrodes were used on all main stress carrying members of this press.

Probably no machinery equipment receives more abuse nor is subjected normally to tougher service requirements than road building machinery. In fact, the very largest equipment of this type is arc welded, and could not be constructed satisfactorily in any other way.

The extensive use of covered electrodes for the past fifteen years in the petroleum industry is undoubtedly well known to all of you.

A field which is absolutely dependent upon the use of covered electrodes is that of various grades of stainless steel. Kitchen fittings including tables and cupboards are typical examples of stainless clad steel fabrications produced entirely with covered electrodes.

The hard surfacing field is also dependent upon covered electrodes of various types. In the construction field where excavating machinery is used, the dipper buckets and teeth are built up with covered high manganese rods. This same material is used for restoring special track work such as manganese frogs and crossings. In the hard surfacing field where high abrasive action must be resisted by members made of cast iron, excellent results are obtained by employing special coated rods for cast iron.

Probably one of the outstanding developments of recent years is the rapid expansion of welding in the construction of railroad cars, both passenger and freight. In the case of passenger cars much of the welding is done by the spot welding process, and one railroad in particular has applied the process to a portion of its freight car construction. However, even here a considerable proportion of the welding is done with the covered electrode arc process.

When the car construction involves main framing the covered electrode process of welding is inherent. Cars of this type are made with one or more of the relatively new high strength steels, and therefore require special electrodes. In this particular case the covered electrode used produces weld metal having an ultimate tensile strength of 80,000 to 100,000 pounds and ductility of 25% elongation in 2 inches.

Another outstanding example of mass application of covered electrode arc welded construction is that of the Duryea cushion underframe for railway freight cars and cabooses. Ten years ago only fifty cars were so equipped whereas this year the total will reach at least 24,000, more than 11,000 of which have been equipped within the last two years.

Probably the most interesting new development in welded construction is an all arc welded locomotive boiler just finished by the Delaware and Hudson Railroad with the permission of the Interstate Commerce Commission. This boiler is being put in service as a stationary boiler for a preliminary period of six weeks after which it will be put in regular road service on a standard D. & H. R. R. Class E-6-A locomotive.

Space will not permit a detailed description of this boiler but a few principal items will be of interest. The main "barrel" portion is a frustum of a cone being 88 inches outside diameter at the smokebox end and 94 inches outside diameter at the firebox end. The plate thickness is 1 1/16 inches. The working pressure is 225 pounds per square inch. All welds in the boiler shell were stress relieved in line with the A.S.M.E. Boiler Code for power boilers, before the firebox was attached. Before the shell was placed in the furnace the "mud ring" was bolted to the shell to stiffen it. The flat and circular parts of the shell were also thoroughly braced, and as a result there was no change in contour resulting from the 1150° F. temperature in the furnace.

Truly, we are at the threshold of an age of welding. One could go on and on citing examples, but these are sufficient to indicate the trend of the times.

SELECTION OF INSULATED CABLES FOR STEEL MILLS

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Abstract of paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ THE purpose of this paper is to review the fundamentals of cable engineering, discuss some of the advances in the art of cable manufacture, and to show how important many factors are in the selection of cables to make them more dependable.

Different engineers use different kinds of cable in a steel mill under practically identical conditions and they all work. But they must all start with the correct application of the fundamentals of cable engineering, in order to arrive at the best construction.

All component parts of a cable are equally important. Balanced design is paramount to obtain best results; that is, the choice of a cable should be made to meet all the requirements of installation and operation. Since the cost of cables in a steel mill is but a small percentage of the total cost, even the most expensive construction would not be prohibitive.

The factors involved naturally fall into three groups; design, installation, and operation. The factors in the design of a cable which determine its ability to keep the mill running are:

Operating voltage and frequency, a-c or d-c
Grounded or ungrounded neutral
Ambient temperature
Duct, aerial or submarine installation
Kind of insulation
Shielded or non-shielded type cable
Daily load cycle
Single or multiple-conductor
Type of sheath or protective covering
Conductor size and current-carrying capacity
Cable diameter.

The discussion concerns principally making the proper provision for the conditions under which the cable is installed, adequate protection of the installation for overall dependability, and those items required to determine the current-carrying capacity of various cables. This subject is discussed in some detail. It is pointed out that current-carrying capacity calculations are based on temperature rise and must be carefully carried through to obtain the correct result.

The reasons for choosing various kinds of installation are given for a variety of applications. These include paper, varnished cambric, rubber and asbestos-insulated cables.

Included is a discussion of other general factors of design applying to all types of cable and more than one kind of insulation, including the following:

Single vs. double circuit
Choice of cable with or without braid
Minimum bending radius
Lead sheath vs. rubber jackets for control and power cables.

Installation

The conditions of installation naturally have a direct bearing on the application of the cable for satisfactory results. Briefly, these conditions must be recognized in selecting the proper cable design and the most favorable methods and practices should be followed when the cables are installed.

Some of the factors are:

Size, location and condition of duct banks, conduits or other cable locations
Presence of nearby furnaces, steam and hot-water pipes or hot spots
Presence of moisture, solvents and corrosive ingredients

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Freedom from mechanical damage during installation
Freedom from vibration
Training of cables
Jointing methods and workmanship
Ventilation
Selection and installation of potheads when required
Grounding and bonding of lead sheathed cables
Fireproofing

Operation

Methods of operation have a decided influence on reliability, maintenance and cable life. After the cable has been properly designed to meet its requirements and installed in a manner to insure safe operation, it is only good business to protect them from abuse and unsafe practices. Some of the factors of importance are:

Protection against overload and overvoltage
Protection from external heat
Protection against mechanical damage
Routine inspection for protection against corrosion and electrolysis (if metallic sheath is used)
Cable sheath grounding and bonding.

Design and rating of duct banks, conduit construction, cable sheath grounding and bonding and other items of installation and operation are discussed. Advantages and disadvantages are shown for various constructions of duct banks, and attention is drawn to the reasons why some features of design and installation encountered in every day work are preferable or should be avoided.

The paper is intended to clarify some existing uncertainties about cable design and installation and to be of practical help to the steel engineer.

COLD ROLL FORMING OF STRIP STEEL

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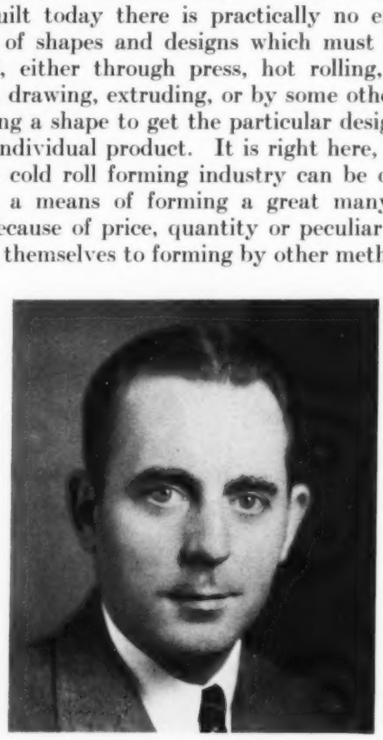
Abstract of paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ IT is of course axiomatic that standard hot rolled structural shapes are the lowest in cost and it is rather probable that they will continue to be. However, it by no means follows that hot rolled sections are in every case the most desirable for the particular job under consideration. On the contrary, with the mounting demand for lighter weight sections from scores of industries, it is today possible to secure strength with lightness, either by ribbing or rolling a box section. Our problem, it frequently follows, is to turn out a section that is sufficiently light so that the saving in material justifies the additional expense of the rolling.

The basic trend all along the line today toward light weight construction immediately brings to mind the picture of steel houses, employing light weight construction throughout. The day is not far distant when some one will make come true the mass production of pre-fabricated houses on a truly Ford scale. Cold roll forming is bound to play a big part in any such program, just as it already has played a part in connection with the tremendous strides that the railroads have made in the last year or two in reducing the weight of their rolling stock. Truck and bus bodies are constantly being made lighter and lighter without sacrifice of strength, and here, too, cold roll forming has played an important if inconspicuous role.

Where close tolerances are important, the cold rolled section is the answer to the problem. The mills set liberal tolerances on their hot rolled sections and it is not practical for them to do otherwise. The cold roll forming machine, on the other hand, because of its flexibility of adjustment, is able to roll to close tolerances with ease. Moreover, the hot roll mills are geared only to quantity production or to requirements that fit in with quantity production. In order to get a hot rolled section, one has to accept standard mill sections, or the volume of production must be sufficiet to justify the initial cost for the special rolls required to produce the section. In the ramification of products being built today there is practically no end to the number of shapes and designs which must be manufactured, either through press, hot rolling, cold roll forming, drawing, extruding, or by some other method of forming a shape to get the particular design desired for the individual product. It is right here, therefore, that the cold roll forming industry can be of aid, for it offers a means of forming a great many sections which because of price, quantity or peculiar shape do not lend themselves to forming by other methods.



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Furthermore, where time counts greatly, cold roll forming speeds up the picture remarkably. A set of rolls for the average shape can be turned out by our industry in a comparatively short time, facilitating quickness of delivery. Moreover, the cold roll forming of strip steel leaves the fabricator with many sources of supply, so that he is not tied down to any particular mill or warehouse, and the strip—either in the sheet or in the coil—can be stocked and slit and used as required. Finally, the rolls are quickly interchangeable on a cold roll forming machine.

Among other advantages of cold roll forming are high production speed, low initial tooling and machine cost, low unit rolling cost, saving in floor space, low operating cost due to lessened power consumption, and the fact that a section can be completely formed in one pass. The ever changing models in every field of industry today are pointing the way to almost limitless possibilities for the further development of cold roll forming, which is so quickly adaptable to changing requirements. I wonder if it is generally known that it is not only possible to run a piece out of a forming machine to whatever length desired, but also to cut the piece, bend or coil it, punch it, paint it, solder it, tin it, plate it, braze another coil on—all in one continuous operation.

Mention has been made of the part that cold roll forming will play in the production of the new light-weight, all-steel houses. Cold roll forming will be found the ideal method for the rapid production of such sections as box columns, electric conduit pipes, studding, door bucks, framing, metal trim, rafters and ridges, conductor and down-spout pipe and gutters.

Standardized metal trim, stained and grained so that it is really beautiful as well as fire-proof, will be the rule before very long on all ocean-going vessels. Cold roll forming will play an important part in all this, as it will also in the production of light-weight steel furniture, which now is only in its swaddling clothes. Even on the farm it won't be long before steel barns and silos, fire-proof and properly insulated to prevent spontaneous combustion, will be commonplace.

The new light-weight, rust-resisting, alloy steels are concededly one of the miracles of the age. The steel industry is faced with new concepts, new objectives, new ways of doing things. Some of the most constructive thinking in the world is being done these days in the metallurgical laboratories of the steel mills. And as the steel industry goes forward to new heights of achievement, the cold roll forming industry is doing its best to keep in step, ready to meet the thousands of problems that loom on tomorrow's horizon.

STEEL MILL LUBRICATION

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Abstract of paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ REGULAR inspection and lubrication schedules should be established by the mechanical or maintenance department in conjunction with the engineering and operating departments.

Lubricants must act to: (1) Still further reduce the already slight internal friction in the bearing. (2) Dissipate heat. (3) Aid in keeping out foreign matter such as water, scale, etc. (4) Prevent rust and corrosion. Holding bearings and lubricants to a uniformly low temperature will aid materially in maintaining gauge and quality of rolled products as well as increasing the life of the lubricant and reducing maintenance.

EP lubricants should carry a minimum load of 30 lbs. on the Timken Lubricant Tester. Care should be exercised in their use if copper bronze bushing are used, as active sulphur compounds will attack the copper.

For gear units, satisfactory results are reported with lead-soap-sulphur base, chlorinated sulphur base and phosphorous compounds in the EP type of lubricants. In greases, various types of EP lubricants with sulphur-saponificable, lead-soap-sulphur, chlorinated and phosphorous types or combinations show satisfactory results.

MANUFACTURE AND USE OF IRON AND STEEL ROLLS

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Abstract of paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ ROLLS being the working tools of a mill offer a subject of wide interest to mill men and the idea of this paper is to cover their manufacture from a foundryman's point of view. This will be done in a pictorial manner covering the various stages of operation in the foundry.

Not much has been written or said publicly on this subject for the reason that all of us engaged therein realize the many problems that enter into the production of good rolls for your use, and we are reluctant to go on record too strongly, advocating any method of production that will apply to all types, sizes and compositions that seem to be required today. What may be shown by the slides and written in the paper to be presented, represents the practice at our plant and may or may not apply in detail to other makers.

We are called upon to make many shapes of rolls including roughers, intermediates and finishers. These rolls require rapid cooling or what may be called chilling in the passes to give a condensed metal to the working parts.

The so-called Phoenix Metal is, in most cases, cast direct against a bare chill made of cast iron. To do this successfully the temperature of the metal must be within a range of fifty degrees fahrenheit. If the tem-

perature is too high, you will burn the chill and there is a mixing of roll metal with the chill metal that may not cut out within finish dimensions. If the temperature is too low, rapid solidification causes irregular contraction or extreme surface tensions of the contacting-roll metal against the chill and the result will be a surface crack that may or may not cut out within finish dimensions.

Molding, melting and heat treatment practice of various compositions will be discussed.

Mr. MacQuarrie will, in the presentation of his paper, cover: The wear of roll passes. The relation of angle of contact and projected contact area to wear.

Controlling, or working, diameter of passes including comparison of several designers. Induced control on some shapes. Influence of ragging on controlling diameter of passes. Influence of rough rolls on controlling diameters. Comparison of diagonal or compression rolling, as compared with the conventional oval and diamond to square passes. Roll breakage.

PROTECTIVE ATMOSPHERES FOR ANNEALING FURNACES

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Abstract of paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ THE subject of atmospheres for furnaces has engaged the attention of investigators for a number of years, and the literature contains many valuable references and records of their painstaking work.

The earlier work refers more especially to the effects of various atmospheres for carburizing and for preventing decarburization, while the later work refers extensively also to the protective properties of gases for bright annealing.

While most of these papers treat the subject from the scientific viewpoint, recording the results of experiments in apparatus of laboratory size, and although there is some lack of agreement in the results reported, due to failure to recognize the effects of impurities such as oxygen and moisture, nevertheless, they form the basis upon which much of the recent rapid progress in this field has been founded.

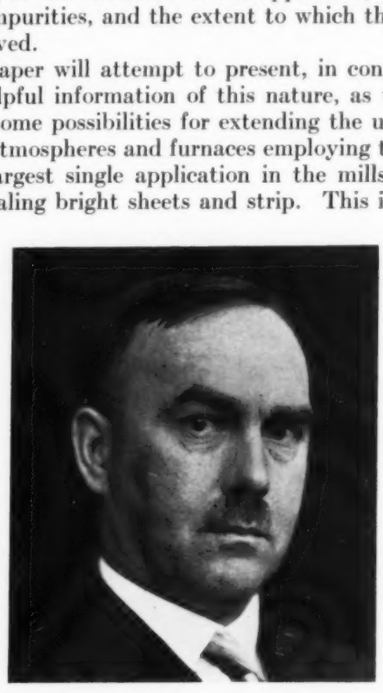
The importance of suitable protective atmospheres for annealing furnaces in steel mills can hardly be over emphasized, and while the use of such atmospheres is being rapidly extended, yet, there is much useful information which has not been put in such form as to be readily available to those who actually use the apparatus.

It is not the writer's purpose to review the work of the investigators, but rather by drawing from them, and from experience, in order to define the requirements for atmospheres for such purposes as bright annealing sheets and strip, annealing carbon and alloy steel bar stock, silicon steel sheets, stainless steel, etc. Also to describe apparatus for these applications, and point out the limitations and extent of purification required for the various processes.

Since success of these processes depends to a large extent upon the selection of the proper atmosphere for the specific purpose, and its subsequent treatment to remove objectional elements, such as water vapor, it is essential that the operators have a clear understanding of the functions of the apparatus, the effects of the impurities, and the extent to which they should be removed.

The paper will attempt to present, in concise form, some helpful information of this nature, as well as to outline some possibilities for extending the use of protective atmospheres and furnaces employing them.

The largest single application in the mills today is for annealing bright sheets and strip. This is of great



A. N. OTIS

economic importance, and fortunately is one of the simplest of the processes using protective atmospheres. Most of the mills have apparatus for producing atmosphere for this purpose, consisting of equipment for partially burning coke oven gas or natural gas under controlled conditions.

This apparatus, although introduced only a few years ago, has come into wide use through the advantages which it offers, namely a cleaner and better product, at lower cost and with greater safety, than is possible by the use of raw gas formerly employed. It is a splendid example of contributions from those outside the industry, since it was developed for quite a different purpose.

Even though these equipments are used widely there appears to be some confusion as to the requirements particularly as to the permissible or desirable moisture content for bright annealing steel, as evidenced by purchaser's inquiries. Some of these specify the use of absorption dryers to remove the moisture content to a very low value, others specify refrigerated coolers to remove it to a moderate value, while others get entirely satisfactory results without the use of either.

The laws governing the reactions in these complex gases were outlined by Marshall in 1933, with experi-

mental data to confirm. It was shown that the gas, if too dry, will etch bright steel, producing a grey matter finish, particularly if the CO content is high. It was also shown that for most of the gases tested a considerable moisture content is permissible, that it could be varied over a fairly wide range, and, in some moistures, was made as high as 20% without change in appearance of bright steel.

Since this portion of Marshall's work is particularly pertinent, it will be briefly reviewed, and the essential facts re-stated, together with relations existing between the hydrogen and water vapor; the extent to which water vapor may be present without injurious results thus avoiding the cost of unnecessary removal, and the field of application of cooling and drying methods.

This subject will be approached from the practical standpoint of the user and operator, because numerous contacts in the field have convinced the writer that these subjects are not well understood, and because it was necessary for him to expend a considerable amount of time and effort to get this and the other related data into suitable form for his own understanding and convenient use.

D.C. DRIVES FOR RUN-OUT TABLES AND COILERS

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Abstract of paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ THE writer believes in the advantage of d-c motors for driving the rollers of runout tables and coilers of modern wide hot strip mills. Under this system each roller or each pair of rollers is equipped with an individual mill type d-c motor, ranging in capacity up to 7.5 or 10 hp. in case of tables, and up to 25 hp. in case of coilers. These motors are subdivided in groups (up to 60 or more per group), and each group is supplied with power from a d-c generator. Ward-Leonard control is used to start, accelerate, slow down, stop, or reverse each table section or each coiler.

The writer has suggested this system late in 1936, in connection with the then proposed 98-inch hot strip mill,—in preference to the previously considered standard method of using squirrel cage induction motors and adjustable frequency M-G sets. Since that time not only the 98-inch mill in question, but a 44-inch and an 80-inch hot strip mill were laid out and ordered with d-c motors for tables and coilers.

What is the reason for this change in trend from a-c to d-c? The present paper attempts to answer this question as the author sees it.

The idea of individual drives for table rollers is more than 25 years old. The Company with which the writer is associated has built them since 1911. The mills considered in the earlier years were either narrow strip or hoop mills, or merchant bar mills. The table rollers were light and narrow. Each required a motor of, say, ¼ hp. or ½ hp., and the aggregate capacity seldom exceeded, say, 100 hp. or 200 hp. Table rollers were ordinarily kept running continuously. Under the circumstances it was most logical to make these small motors of squirrel cage type, and to control their speed as a unit by raising or lowering the supply frequency. Many very able papers were presented before the Association dealing with drives of this type.

With the advent and growth of the wide strip mill the capacity of the table and coiler drives grew by leaps and bounds. In some cases the total capacity of motors has been over 2000 hp. for a single table. The several table sections and the coilers had to be individually started and stopped. The converting plant consisting of d-c to a-c motor-generator sets included in some cases six or more sets, aggregating well over 3000 kva.

It then became apparent to some of us that the very capacity of the apparatus made the otherwise good system unyieldy, uneconomical and inefficient.

Its first and inherent handicap is that of any adjustable speed a-c drive. We take it for granted that the squirrel cage motors are simple and rugged. However,

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the only means of adjusting their speed is by varying the applied frequency. There is no good and practicable means as yet developed of providing commercially a source of adjustable frequency, except in a rather crude way, by means of a d-c to a-c set.

Since the power supply is usually a-c, this means that another, a-c to d-c set, is used somewhere in the system to provide power to run the adjustable frequency sets. Thus, the power is converted through five machines in succession, from a-c supply to table rollers. Low overall efficiency and high first cost of the converting plant, per unit of power, could be readily neglected at first, when the total amount of power involved was small. However, for a wide strip mill this problem becomes of real magnitude.

Likewise, a squirrel cage motor, simple and therefore attractive as it is, is not particularly well adopted for

a rapid start-and-stop service. It is well known that such motor, connected to an inertia load and started at full frequency, will absorb as heat in its rotor as much energy as the kinetic energy of rotating masses at full speed. Plug this motor and bring it and the load to rest—and you absorb in the rotor three times that amount of energy. Or, cut it off the line while running and stop it by d-c dynamic braking—and again you put into the rotor as much heat as you did while starting. All this is over and above the stator losses of the motor. Since the WR^2 of table rollers of a wide strip mill is quite appreciable, the amount of these extra losses not only overheats the motors (or calls for bigger motors than otherwise necessary) but results in an outright loss or waste of power. Since all this power has to be converted several times, beginning from the a-c supply, the resulting tax on the "coal pile" is something that none of us can be proud of.

It is right here that the d-c system, as proposed by the writer, steps in its own. Each group of motors, say 30 to 60 per table section, is connected electrically to a d-c generator. To start the table—the generator voltage is built up. To stop it—the voltage is rapidly brought to zero, and the table motors are pumping their energy back. There are no losses similar to rotor losses of squirrel cage motors, described above.

With motor heating reduced so markedly, it is quite obvious that a smaller continuous capacity is required if d-c drives are chosen in preference to a-c, with the external work done being exactly the same in either case. With this system there are three transformations of power from a-c supply to table rollers instead of five. The conversion losses are easily cut in half.

An analysis recently made along these lines has shown that the extra power loss in case of a-c drives may easily exceed, in case of a wide strip mill, 1,500,000 kw-hours in a year. At .7 cents per kw-hour, the use of d-c drives is apt to save over $10,000 per year in power cost alone.

It is ordinarily necessary to adjust separately the speed of each section of the mill runout table—and there usually are five or more such sections. Independent starting and stopping of each table section and, of course, of each coiler are also in order. Therefore, if a-c drives are employed, seldom less than five motor alternators are used, and in some instances seven sets were installed (for a single-line table and two coilers), not counting the dynamic braking M-G set. These sets and the rather elaborate control equipment take not less than three 25 ft. x 65 ft. bays of motor room building.

As against this, the several generators for the d-c table and coiler motors can be conveniently grouped into one or two sets driven by 2200 volts or 6600 volt motors, as the case might be. The control equipment being of the Ward-Leonard type is elementarily simple and compact. Only small contactors are used to control the generator field. One building bay instead of three is often sufficient. This saving in space can be readily evaluated in many thousands of dollars.

Mention was already made that the adjustable frequency motor alternators require d-c as a source of power. 600 volt d-c supply available for finishing mill motors is often used for this purpose. Some engineers are apt to forget that this source of power is not unlimited, particularly when the 600 volt bus is split into several sections. The several motor alternators add a steady load of not less than 1000 kw. or more, and the peak load may easily exceed 3000 kw. Thus, the capacity of the 600 volt M-G sets should be suitably increased,—and the corresponding extra cost debited against the a-c table drives.

D-c motors cost more than the squirrel cage motors. On the other hand, the a-c to d-c M-G set and control equipment is less expensive than the adjustable frequency motor-alternators and corresponding control usually required for a wide strip mill. Taking the equipment as a whole, the two types of drives are quite competitive, even neglecting the pro-rated cost of the 600 volt M-G sets. With the latter figure thrown in—the scales usually tip definitely in favor of the d-c system.

The next natural question is this: What about maintenance of the d-c drives? There is no use denying that it is apt to be higher, everything else being equal, than that of the squirrel cage motors, due to the wear of brushes. However, one must remember that the maintenance of any drive is that of the motors and control. The latter is so much simpler and so much easier working with d-c drives that it is questionable whether the total maintenance expense will be higher. We will know it better in a year from now.

In the meantime there is one argument which should be very difficult to refute. For years the steel mill engineers have selected for their toughest jobs the mill type d-c motors. Who would, for instance, consider even half-seriously the application of an a-c motor for a blooming mill screwdown, or a sideguard, or a charging machine? Why do we make this choice even though we realize that a-c motors are free from commutators and brushes? The answer is only one: We do it because we know that the d-c motor and control will do a better job than an a-c motor and control. And, the writer is reasonably certain that the runout table and coiler drives will not prove an exception to this rule.

It is far from the writer's intention to advocate d-c drives for all runout tables regardless of size. He still believes that when the amount of power involved is relatively small, and when starting and stopping is not very frequent—the a-c motors will hold their own. Cost analysis will decide the issue in specific cases.

Good engineering is still based on the time-honored principle: Never follow a beaten path. Stop, look—and think. There is always a better way.

SURGES AND THEIR EFFECT ON TRANSFORMERS

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Abstract of paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ IN order to insure the continuity of electric service which is so necessary to our industrial life, we must

protect the transformers, contributing to that service, from lightning, and the transient voltages which may be produced by switching operations or arcing grounds. The purpose of this paper, is to discuss briefly the means available for protecting transformers from these abnormal voltages.

If a transmission line is subjected to a dangerous voltage, the line insulation, or the transformer connected to the line are apt to flash over and perhaps fail if not adequately provided with lightning protective equipment and connections.

Since it is impossible to control natural lightning, methods of producing and recording the effects of

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artificial lightning have been devised to study ways and means of delivering more constant and uniform electrical energy to the customers of generating stations.

Protective means now in general use include some form of lightning arrester as a primary protector, and a rod gap as a secondary protector. The rod gap is also used for the measurement of the voltage to which the transformer is subjected during a test. Certain connections may be used to protect a transformer. However, most of such circuits are applicable only to single phase transformers or to wye wye connected power banks.

The forerunners of our modern lightning arresters included:

1. A bushing with electrode so incorporated therein that a spill-over occurred before a dangerous voltage was reached. One objection to this protector is that at low values of ground resistance there is very apt to be a follow current from the line, which after a few cycles becomes a menace to the transformer, due to the power arc scarring the porcelain.
2. Horn gaps that were intended to eliminate dangerous voltages from the system, but which often allowed the fuses to blow before the arc was extinguished by the natural action of the gap.

Modern lightning arresters fall under two general classifications. One is a gap with the ability of generating gas at very high pressure which extinguishes the arc immediately after the impulse has passed. This type of arrester is known as a gas quenching type. The second class of arrester is of the impedance type. This arrester has in series with the discharge gap a material which at relatively high voltages has a low resistance but an impedance so high that an arc cannot be maintained after the surge has passed.

The impedance type arrester may subject the protected equipment to a higher voltage than that required to initiate the discharge, if the surge current which flows is large. The gas quenching type of arrester does not have this voltage characteristic, but drops the impulse potential to substantially the line voltage, regardless of the surge current which flows. Both of the above mentioned types of arresters will limit the flow of dynamic current to less than 1 cycle under most operating conditions.

When an impulse of sufficient magnitude and energy is applied to a transformer to cause a flashover of the secondary means of protection, (rod gap or bushing) follow current may or may not flow depending upon the part of the power wave struck by the surge. The percentage of the power cycle which is vulnerable is dependent to some extent upon the value of ground resistance at the transformer location.

The effect of ground resistance on the operation of transformers is much underestimated. At normal frequencies it is not so important but when considering surge waves and lightning arrester discharges the ground impedance produces the same effect as an increase in the impedance element; that is, raises the voltage across the major (high to low) insulation in the transformer thereby causing either an internal rupture or a flashover of the secondary protection with consequent system outage.

For all practical considerations, the surge current which can be delivered by a lightning stroke not adjacent to a transformer is equal to the surge voltage divided by the surge impedance of the line. The surge impedance of the line is a function of the capacity and inductance and the ohmic resistance of the line produces only a slight attenuation.

The impedance offered to a surge by a transformer is principally capacitative. Therefore a schematic diagram of a transformer under surge conditions can be represented by a network of capacities, and calculations can be made to determine the probable voltage distributions over the different insulations which are used.

The circuits which are used to reduce the hazard lightning on transformers are many and varied in nature. The simplest circuit connects the secondary neutral of a single phase transformer to the lightning arrester ground lead either solidly or through an isolating gap. This circuit very materially reduces the amount of voltage which may appear across the major insulation of the transformer. In the year 1912 Creighton pointed out the advantages of using such a circuit. The circuit has become known as interconnection during recent years.

Tests carried out at Purdue University under the sponsorship of the Utilities Research Commission proved the value of using inter-connection. Later the Commonwealth Edison Company installed a large number of interconnected transformers on its system in Chicago. The first year of operation showed a 65% decrease in transformer trouble due to lightning.

In all transformers of modern manufacture, the insulation is designed so that the protective gap across the bushing is the weakest point. If this gap flashes, very little, if any damage occurs to the transformer but of course a system outage takes place. This so-called coordination of insulation does not stop with the transformer itself, but should be and generally is extended to the lines feeding the station and carrying the power away from the station.

A further cause of service outages is the blowing of primary fuses. These fuses can be blown by surge current if the fuse is located in the wrong position in the circuit and a surge of great enough energy is allowed to pass.

THE USE OF EXTREME PRESSURE LUBRICANTS

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▲ THERE has been so much general information given recently on the subject of extreme pressure lubricants that probably everyone has a fairly good general idea of the nature of such products. However, there still seems to be a general lack of understanding of their various characteristics and on the question of when and where they should be used.

Their present general application to steel mill lubrication is a direct result of an experimental application on one of the early 4 high continuous hot strip mills when load conditions on both roll neck roller bearings and mill drives became too severe for ordinary lubricants to handle. It was evident from these tests that lubricants were available which would hold up under high tooth and bearing pressures and it only remained to develop a technique for an extension of their application.

The application of extreme pressure greases to the roller bearings for roll necks is now quite fully developed and can almost be considered standardized.

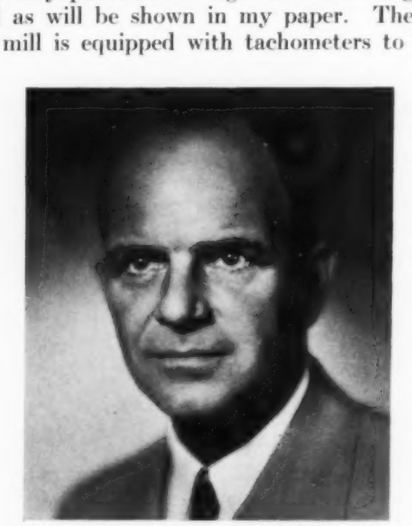
Although this extreme pressure grease was developed primarily for large, heavy duty roller bearings it is definitely a general purpose grease, working equally well on either plain or anti-friction bearings and at speeds and temperatures generally encountered in mill operation. This characteristic offers many possibilities for simplified mill lubrication, particularly in conjunction with centralized pressure systems. There are today several mills operating with this single product on every grease lubricated bearing, plain, anti-friction, or sliding, from furnace table and slab return to coiler.

The factors determining the use of extreme pressure lubricants in mill drives are of course loads and operating conditions, but for proper and economical lubrication these loads and operating conditions must be carefully analyzed to definitely determine whether they are necessary or whether the efficient yet low priced regular gear lubricants will handle the job. This can be done readily because approximate calculations are comparatively simple and loads under actual operating conditions can be readily checked.

For simplicity, let us take the individual factors entering into these determinations, although in most cases several of the factors are actually involved. First, we have the comparatively simple case where changes in product requirements or operation have increased the loads on existing equipment to a point where old methods of lubrication are resulting in drive failures. In such cases the necessary change-over to an extreme pressure lubricant is definitely required.

Next we have the case where structural limitations determine the size of drives. This applies principally to the pinions driving the work rolls of 4 high mills. These pinions, although limited in size, must transmit all loads which the mill motor is capable of delivering or which are required in the rolling of the strip. These loads may even approach the strength of the material in the pinion teeth. Operating and experimental data indicate that a good gear lubricant will satisfactorily maintain a protective film at tooth pressures up to about 3,500 pounds per inch of face. At pressures above this figure an extreme pressure lubricant is definitely required.

For a simple and quick analysis of pinion load conditions on any particular 4 high mill I use a graphical method as will be shown in my paper. The typical 4 high mill is equipped with tachometers to indicate



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motor or work roll revolutions and ammeters to show motor loads. With a fixed pinion size, tooth pressures are directly proportional to the ampere load and inversely proportional to the revolutions. The chart is read in the following manner: The motor speed as shown by the tachometer is on the right hand scale. Reading vertically to the diagonal line for the pinion stand in question shows the pinion revolutions directly on the center vertical scale. Reading horizontally left to the diagonal line showing the ampere load will give the approximate tooth pressure in pounds per inch of face on the left hand horizontal scale. Using such a

chart permits a quick and fairly accurate check on teeth pressures for any operating set up.

I have shown a dividing line at 3,500 pounds pressure per inch of face as the upper limit for safe lubrication with an ordinary gear lubricant. Between this point and another dividing line at 7,500 pounds is the zone definitely requiring an extreme pressure lubricant. Above this point pressures are approaching the limit of strength of the material in the pinions and definitely constitutes a danger zone. A protective film at pressures in this danger zone can only be maintained by a careful selection of a suitable grade of extreme pressure lubricant.

This development of the application of extreme pressure lubricants to the gears of mill drives has led many builders of drives to take advantage of the heavy load carrying capacity of these products and they are now designing drives utilizing a higher tooth pressure figure. This permits a more compact design of unit with a better load distribution on the gear teeth and more efficient bearings.

This covers in a brief and general way the application of extreme pressure lubricants to mill drives where tooth pressures alone are the determining factors. However, a unique characteristic of these products opens a field of applications which is perhaps broader than that covered by load considerations alone. This characteristic is its efficiency as a bearing lubricant. By using these products bearings will run as cool or cooler than with an oil of the same viscosity and in general they also carry the approval of the anti-friction bearing manufacturers.

We are all familiar with the more or less general difficulty experienced with mill drives using a gear lubricant on the gears and a lighter oil on the bearings, due to contamination. An extreme pressure lubricant offers an ideal solution of this problem, for with its high film strength a viscosity light enough to suit the bearing clearances and speeds will still give adequate tooth protection as well as perfect bearing lubrication.

This very simple solution is being applied to many existing units where contamination trouble is being experienced and many manufacturers of mill drives are incorporating this unit lubrication feature in their design with uniformly excellent results.

The extreme pressure lubricants for mill drives do not require any handling different from ordinary lubricants, but I would like to add a few suggestions for obtaining full advantage of their possibilities. Gear lubricants in general probably receive as little care and attention as any in mill use.

We are all familiar with the extreme care given the lubrication system of steam turbines, but many of the modern 4 high mill drives are subjected to loads far in excess of any on the turbines as well as contamination and extremes of temperature but the lubricant receives much less attention.

While extreme pressure lubricants have less variation in viscosity at different temperatures than the ordinary gear shields or gear lubricants, it is advisable where gears are operating at tooth pressures in the danger zone to provide cooling for the lubricant during the hot weather or when the drive unit is subject to heat radiation from the mill and to provide heating in the extreme cold weather in order to maintain the lubricant at its highest operating efficiency. The viscosity should be checked at regular intervals and the product adjusted to the proper viscosity.

In addition to this check the lubricant, if used in circulating systems, should be periodically filtered or centrifuged, the frequency depending upon operating conditions.

As far as circulating systems are concerned, the same general standards of capacity, pressure, quantity of flow, etc., apply for extreme pressure lubricants as for circulating oil systems. With these precautions being taken, full advantage of the extreme pressure lubricants can be realized and long life of the product assured.

Pinion and gear drives operating at high tooth pressures put an added burden upon the maintenance department. The manufacturer is furnishing drives with precision cut gears accurately aligned and lapped to perfect contact and they must be kept in this condition as nearly as possible. The alignment is of particular importance. Any deviation will, in general, affect the proper tooth contact. With a proper extreme pressure lubricant in use, with the gears in proper alignment and tooth pressures below the limit of strength of the material in the gears, I have never seen a gear failure from pressure alone. Misalignment seems always to be the basic cause when failure occurs under proper lubricating conditions.

There is no question that these lubricants have taken a definite place in steel mill operation and I feel that as the unusual characteristics of these products become more generally understood and their uses extended, new standards of efficiency and simplicity will result.

CARBON-CORROSION PROOF TANK LINING

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▲ THE term "corrosion proof" rather than corrosion resistant is used to indicate a fundamental difference between materials which are inert due to their own chemical properties when applied, and those which become more or less passive after application during use. Common examples of the latter type are, of course, metals which develop oxide and sulfate films which retard progressive corrosion of the basic metal. Elemental carbon falls in the former classification and is outstanding in its lack of chemical activity. Briefly, it is inert in all but strongly oxidizing conditions.

Hydrofluoric acid, for example, has no effect on carbon in any concentration. It is this property in particular which makes it exceptionally valuable to picklers of 18–8 and allied steels.

Fortunately, it is possible to produce carbon in fabricated forms, such as brick, without addition of foreign bonding agents which might detract from the inert character of the element itself. Fabricated forms are practically pure, and therefore, have elemental characteristics throughout. There is no film which has to be protected, and no danger of a foreign bond dissolving to permit disintegration. Change of characteristics due to aging does not occur either chemically or mechanically.

In addition to being chemically inert in practically all conditions, this material also has interesting mechanical properties. While it is not malleable or ductile, it is rugged. It is machinable by grinding or tools, and in forms such as are used for tank linings, it can be handled as ordinary brick would be without danger of breaking or chipping. A list of physical properties will serve to illustrate these points:

Compressive	3000 lbs./sq. in.
Tensile	1000 lbs./sq. in.
Transverse Modulus	1700
Coefficient Expansion	.000001 per F°

Of almost as much interest as the chemical properties is the coefficient of expansion. This value is so low that there is no danger of a carbon lining expanding more than a retaining shell, causing wall distortion or shell breakage, which sometimes occurs with high coefficient of expansion materials.

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With chemical and mechanical properties as near ideal for pickling tank service as can reasonably be expected, the method of application becomes the major problem. Unfortunately, we see no immediate prospect of producing monolithic tanks of the size required by the steel industry, and even more disappointing to many tank users is the fact that this material can't be melted and poured into place or applied with a brush.

This, of course, leaves only one alternative, i.e., to build up a masonry wall using carbon in some suitable shape properly cemented together to form a strong, rigid mass. While reasonably large slabs can be produced and are regularly used in some types of chemical process equipment, for tank lining work, regular brick shapes adapt themselves most readily and present less difficulty in laying up than the slabs. Fortunately, adhesion between carbon and any cement which we have seen is good. Therefore, any cement suitable in the particular chemical conditions involved is satisfactory. For nitric-hydrofluoric acid combinations, sulfur-base cements containing carbon fillers have proven themselves to be entirely satisfactory. Excellent progress in the use of plasticizers in these cements in recent years has done much to improve tank lining practice, and to increase cement life.

Since without special treatment, such as we give pipe and certain other products, carbon is somewhat porous, we have not as yet recommended it for use in tanks except as a corrosion-proof lining to protect a rigid self-supporting shell.

The requisites for a perfect carbon lined tank are not materially different from those of other masonry lined jobs. The shell must be sufficiently heavy to provide rigidity, and is almost universally of steel, concrete, or masonry construction. This, in turn, should be coated with an impervious coating chemically suited to the work involved, and inside of these a carbon brick lining of sufficient thickness to provide final protection should be applied.

This protection is three-fold:

1. Chemical, 2. Thermal, 3. Mechanical.

There are, of course, numerous lining materials, such as the asphalts, rubber, and other organic materials, which are satisfactorily inert chemically for specific conditions, but which are limited to the temperature at which they can be used, and which may be subject to mechanical damage. In order to produce a perfectly tight tank, these materials should be used as the final protection to the shell. They not only compensate for the porosity of the brick, but also for the slight imperfections which frequently occur in laying up a lining. It is important to note that a material which may be subject to chemical attack, if used by itself as a lining material, may last almost indefinitely if protected by a properly laid up lining. The reasons for this are obvious. In a properly laid up lining, the masonry and backing are in such close contact that any seepage can attack at the point of contact only. The seeping acid becomes dissipated before any appreciable attack occurs and there is no possibility of circulation to provide fresh acid to continue the attack. Rubber, various loaded asphalts, asphalt membranes, and alternate layers of plasticized sulfur and asphalt are all giving good service in HNO_3-HF mixtures.

The temperature gradient through a carbon lining will, of course, depend on the amount of insulation provided by the shell outside of the lining, the temperature of the surrounding air, etc., as well as on the lining thickness itself. Actual tests made on a tank made up of a ¼″ steel shell and ¼″ rubber lining lined with 2—2½″ courses of carbon brick, set up with ⅜″ thick poured sulfur cement joints show the following temperature relationships at various points of the system:

Pickling Bath	158°	136°F.
1st Brick Course	131°	113°
2nd Brick Course	111°	99°
Rubber Lining	91°	87°
Air	50°	50°

This is equivalent to approximately 12° and 8.5°, respectively, between the solution and backing per 1″ of lining for the particular conditions on which the tests were run.

Actual operating experience in tanks operating over a period of years shows that ample thermal and chemical protection is afforded to backing or sealing materials by carbon linings using only a 2½″ thickness of carbon under temperature conditions normally existing in nitric-hydrofluoric pickling baths, i.e., up to 170°–180°F.

It is almost impossible to generalize on the weight of construction required to provide proper mechanical strength. Like any other masonry work, this depends on the length and depth of the tank involved as well as on the service to which it is subjected.

There are now in service, tanks ranging in size up to 60′ long with linings ranging from 2½″ to 10″ of carbon. Obviously, when there is likelihood of heavy loads being dropped into a tank, the construction must be heavier than that required for continuous strip or light sheet.

The selection of backing materials and cements is, of course, important, but fortunately, not too difficult.

As has been previously stated, it is not necessary to have a backing material which is absolutely inert in the bath itself, since if any seepage occurs, it will be very little and quickly dissipated. It is important, however, to provide a material for this use which will remain flexible throughout the entire range of temperatures to which it is subjected, and which, if thermoplastic in character, is not thick enough to increase appreciably in volume on heating. If a poured sulfur cement is used, the body of the backing must be heavy enough to prevent boring by the hot cement. Rubber, heavy asphalts painted on, and asphalt membranes are all giving good service. In general, thicknesses of the thermoplastic type of backing do not exceed approximately ¼″.

The choice of cement for bonding the brick is principally chemical. Since the greatest field for carbon in steel pickling tanks seems to be in nitric-hydrofluoric tanks, many cements used extensively in the chemical industry are not applicable and the poured sulfur-base cement is, as far as we know, the only commercially satisfactory material to use.

Cements of this general type have, of course, been used for years, and for hydrofluoric acid are made especially with carbon fillers, which eliminate danger of hydrofluoric attack on silica fillers generally used for solutions not containing this acid.

The laying up of a carbon lining with poured sulfur cement is fundamentally simple. A complete course of brick is laid up on the tank bottom on spacers about ¼″ thick made of either carbon or the cement, with the same spacing allowed between brick, and the cement is poured in the vertical joints until each brick is completely embedded, on 5 sides, in the cement which freezes in place, making a strong, rigid course. Additional courses are laid in the same manner, if required. Wall construction is similar, except that a single course high is laid at a time, and if multiple course thickness is used, and courses in thickness are laid at one time. In other words, the complete wall thickness is poured at once, one course high. Paper strips are generally glued over the open joints to prevent loss of the molten cement.

Like many things fundamentally simple, the technique of handling a poured cement properly is one which is developed through experience, and in our opinion, unless a plant has had experience in this work, it is advisable to employ the services of an engineering company experienced in handling this type of meterial. There is probably nothing more discouraging than trying to find a leak in a lining and watching expensive acid eat away a more expensive tank.

Work on carbon lined pickling tanks for severe corrosive conditions started in 1932, and a recent check on the condition and service of some of the early tanks shows that only minor repairs have been required up to the present time during their life, and that the carbon brick are apparently good for an indefinite period. We believe that performance of this type justifies the terminology "Corrosion Proof".

We wish to take this opportunity to express our appreciation of the work of Atlas Mineral Products Company and Stebbins Engineering and Manufacturing Company, who as engineering firms have been to a great extent responsible for the success of carbon linings in the steel industry.

ELECTRICAL TESTING DEPARTMENT OF A LARGE STEEL PLANT

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▲ NO one today will question the importance of tests. Testing and fact finding are as necessary for economical operation of a steel company as they are with any other manufacturer. With the highly electrified steel mills of today, it has become necessary to have a special Electrical Testing Department.

The development of complicated automatic electrical machinery has made it more and more difficult to make tests. Delicate and expensive testing apparatus and instruments are usually required in order to obtain information about the performance of the electrical equipment with a necessary degree of accuracy.

It can readily be seen, that in a large Steel Company, which is composed of several different works or departments, it is of decided advantage to have one Electrical Testing Department serving all the different departments or works of the company. The centralization of all testing equipment will eliminate duplication of expensive testing equipment by the various operating departments, and will for less expense make possible a well equipped Electrical Testing Laboratory. A group of men, who make it their work and study to

make tests, are also much better suited to find the facts, than would be men who do testing only occasionally. Guess work has no place in the care of modern expensive electrical equipment.

The Electrical Testing Department, in the opinion of the author, should come under the supervision of the Electrical Engineering Department. By separating it from the operating department, the testing engineers will be least restricted in carrying out their work according to their best engineering knowledge. It is, however, necessary that the closest cooperation be maintained between the testing and the operating departments.

The personnel of the Electrical Testing Department should be recruited from technically trained men. Previous experience in the operating department of a steel mill is desirable, and so is experience in the testing department of any of the large electrical manufacturers. The testing engineer should be a practical man and should possess imagination and initiative. He should have a pleasing personality and be of a helpful nature. His work is highly varied and he should be able to adapt himself to the most unusual conditions. His work is often dangerous, and he should, therefore, be alert and a strong adherent of the "Safety First" rule. The testing engineer should be a salaried employee and subject to call at any hour wherever he may be needed.

It has been found practical to distribute the cost of the Electrical Testing Department to the various departments of a steel company in proportion to the amount of electrical energy which is used by each of them. This method of distribution of the cost encourages the operating superintendents of the various departments to make full use of the services of the testing department, since they have to pay their pro rata share of the expense.

There is no question about the necessity and the great value of frequent testing in a steel mill or in its coal and ore mines. No mill superintendent or maintenance superintendent can get the highest efficiency out of his equipment unless he knows the facts about its performance. The trend in recent times has been to equip all large pieces of electrical machinery with indicating and recording instruments, to enable the operators to see for themselves the power input of the machines. This is as it should be, and certainly simplifies the work of the testing engineer, but does not necessarily mean very much to the average operator. Many times it takes a specially trained man to analyze the charts from such recording instruments, in order to determine if the machinery is operating properly. There are, however, many electrical machines, which cannot be equipped with individual indicating or recording instruments, and tests are then necessary to determine if these machines are doing their share of the work, or more often, if they are overloaded. It may be said, that as long as a piece of machinery is not giving any trouble, it isn't necessary to make tests, but it is poor economy to over-motor drives or to delay the making of tests, until the motors have burned up from overload. It is very often desired to change some operation and to increase the load on some certain piece of equipment. An accurate test is then necessary to determine whether the equipment is capable of handling the additional load. The expected power requirement for some certain operation may have been calculated or estimated before hand, but it is the actual load in operation that decides whether or not the piece of machinery will live, and only a test will determine this actual load conditions.

When trouble is experienced on a piece of machinery, it is usually necessary to make tests to determine the nature and the extent of the trouble. In this kind of testing it is frequently necessary, in order to determine what is actually taking place, to use very high speed and very sensitive instruments such as for instance, an oscillograph. After the completion of repairs or adjustments of the machinery, it is again necessary to make tests to make certain that the proper repairs or

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adjustment have been made. High potential tests should always be made on high voltage equipment before it is put into service again after a breakdown. The danger involved in making high potential tests, and the experience required to use sensitive and delicate instruments, make it very desirable, that such tests be made only by experienced testing engineers.

Periodical high potential tests should also be made on all oil used in transformers and oil switches in order to check the dielectric strength thereof to prevent breakdown of such equipment due to the accumulation of moisture and carbon in the oil.

The keen competition in the steel industry prompts a constant development of new mills and machinery which will make a better product at a lower cost. In the design of new mills and machinery, it is very important that the engineering department is supplied with accurate information on the performance of similar equipment already in use. Such information can many times be obtained through a simple test or from the records of the testing department, but sometimes it may require complicated tests, for which special testing apparatus will have to be made. This is one reason, why it is very important, that the Electrical Testing Department should have a well equipped shop and a good laboratory mechanician. By a good laboratory mechanician is meant an expert machinist, who can

understand the requirements of the test and can construct the required apparatus without the necessity of making drawings. There is always enough routine work to keep a mechanician busy. Moreover, a certain amount of research and development work goes hand in hand with a testing department, and in this kind of work it is particularly necessary to have a good mechanician.

It should be the duty of the Electrical Testing Department to keep all meters, instruments and relays in good repair. This is a large assignment, particularly in a steel mill, where the conditions of service are naturally severe. By being able to take care of such repairs in the shop of the testing department, the cost and delay of having to return the instruments and relays to the factory for repairs are avoided.

An up-to-date steel mill uses a great number of protective relays, protecting the many expensive electrical units. These relays must be kept in good operating condition and must be properly calibrated in order to insure at all times, that the proper protection is accorded the various units for which they are intended. It is very important that tests should be made periodically on these relays. The relay testing engineer should have a thorough knowledge of the operating practices of the mills so that he will be able to make the proper adjustments on the relays to give ample protection, and at the same time, give uninterrupted service.

In these days of keen competition it is very important to know the exact manufacturing cost of all different products. The cost of electric current is a large factor in the total manufacturing cost. The ideal way of ascertaining how much energy is used, would be to have a watthour meter on each item for which a cost exhibit is required, but since this is hardly possible, the electrical testing engineers are called upon to make estimates of the consumption of electrical energy. Numerous and frequent tests on different operations will enable the testing engineers to establish kilowatt hour per ton factors, which together with the readings from available watthour meters, make it possible for them to determine accurately the energy consumed by the various operations. The monthly distribution of all energy used by the various departments and branches of departments should be made by the Electrical Testing Department, and for this purpose, tests and studies of the different operations should be made frequently to insure an accurate distribution. Periodical tests should be made on all watthour meters used in this distribution in order to insure reasonable accuracy. This will require frequent tests on many meters which have to be located in places, where dirt and vibration cannot be eliminated, and where it is therefore difficult to keep a meter accurately calibrated.

Comparative tests on new electrical equipment offered by the different manufacturers also constitute an important function of the Electrical Testing Department. Such tests should be made in accordance with the standards of N.E.M.A. or to correspond with the conditions under which the piece of apparatus is expected to work. The performance of such tests by the Testing Department will many times eliminate the necessity of trying out the different kinds of equipment in operation, which is costly and which often does not afford a fair comparison.

There are innumerable kinds of tests which an Electrical Testing Department is called upon to make, only a few of which can be enumerated here. Most steel companies have in one place or another, an underground pipe system for water, gas or fire protection. The study of the effects of corrosion or electrolysis on on these pipe lines is an important duty of the testing department. High tension underground cables are not always free from failures. If such a failure occurs on a long stretch of buried cable, it is desirable to know where to begin to dig to find the fault. A resourceful testing department will usually be able to determine the exact location.

For the safety of workmen it is very important that all high tension electrical machinery and metal structures, which carry high tension transmission lines, be well grounded. Periodical tests should be made to check all such ground connections.

An Electrical Testing Department, if properly used, will pay for itself by safeguarding the expensive electrical equipment, thus preventing many costly failures and delays. In case of a failure it can save the expense of unnecessarily long shutdowns by correct analysis of the trouble or by prompt location of the fault.

It can also effect a saving for its company by keeping a constant check on all power requirements and by discovering wasteful practices.

The work of the Electrical Testing Department is never finished. The opportunities for the services of this department are as many and varied as the manufacturing industry itself. The technical and practical education of the testing engineers, together with their experience backed up by a good store of common sense, will enable them to be of great service to their company.

STEAM GENERATION

From Gas Engine Exhaust in America

By T. A. LEWIS, Combustion Engineer
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BETHLEHEM, PENNA.

Paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ EVER since heavy-duty gas engines found successful application as prime movers in the steel industry, no little amount of effort has been expended in developing a type of waste heat boiler for the efficient utilization of sensible heat in the exhaust gases. So far as it is known, the first designs of waste heat boilers for this purpose in the United States were made in 1918, but the apparent lack of gas-engine performance prevented serious consideration of their application. By 1935, the design had developed to such a point that the unit was reliable and, coincidentally, gas engine performance had been improved to such an extent that the application was warranted. Before the year was over, Bethlehem Steel Company had equipped one of its gas engines at the Bethlehem, Pa. Plant with a waste-heat boiler unit which, except for slight delays in engine operations, has been in continuous service (Figure 1). So successful was this installation that four complete units followed and, at the present time, three additional installations are now under construction. These waste-heat boilers which are equipped with economizers are the first units of their kind to be used in this country to recover waste heat from the exhaust of large gas engines and utilize it efficiently in generating more steam for the steel plant.

T. A. LEWIS

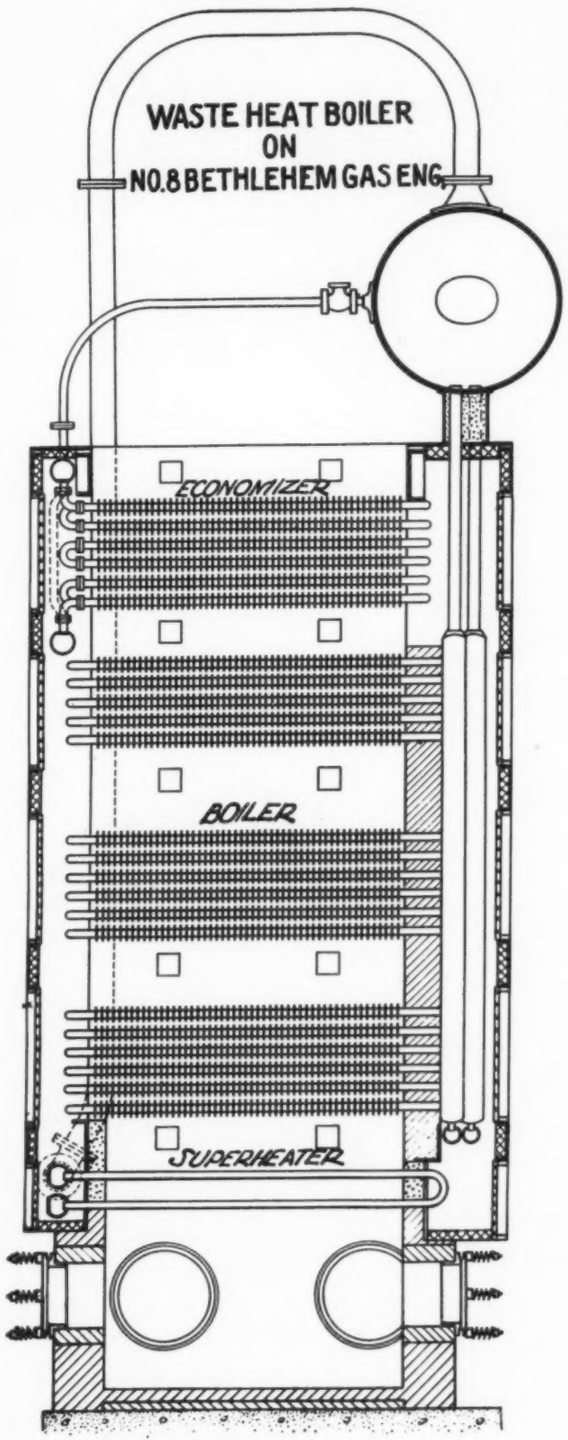
Despite the fact that the trend in mill drives is toward complete electrification, normal steel plant operations still require a large supply of steam. This and all other heat requirements, shown by means of the fuel distribution flow sheet, Figure 2, involve a large quantity of purchased fuel in the form of electric power, oil and coal. By referring to this chart, it will be seen that waste heat distribution represents 6.1 per cent of the total, an amount that influenced the application of waste heat boilers on these gas engines at the Bethlehem plant.

Application of waste heat boilers in industrial plants dates back to the past century. The early installations employed plain cylindrical drums, under which the flue gases were passed. These units were up to 5 ft. in diameter and 40 ft. long, low in efficiency, but capable of producing sufficient steam for plant requirements. Waste heat boilers in open hearth furnaces have been used extensively in the United States since 1910. During the early stages the multi-pass water-tube boiler was favored, as it conformed to standard boiler practice and produced gratifying results. Later developments called for the fire tubular boiler which was more efficient and less costly in installation. This is now the favored type for open hearth furnaces.

Application of a waste heat boiler to a gas engine is simpler, less costly, and more effective than to a metallurgical furnace, because it obviates the necessity for auxiliary equipment such as fans. No infiltration of air takes place as the boiler is on the pressure side, and clean gas and engine cylinder pulsations eliminate daily external cleaning of tubes.

Use of internal combustion engines in Europe antedated their use in this country where the trend has been toward units of greater simplicity, at the expense of fuel economy. The superiority of the turbine over the reciprocating engine, and its larger capacity per

Figure 1—Waste heat boiler on No. 8 Bethlehem gas engine. This has been in continuous operation for the past two years.



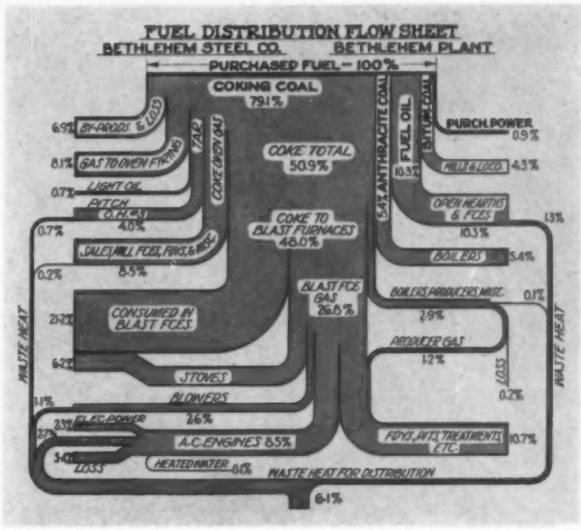


Figure 2—Fuel distribution sheet showing the percentage of waste heat distribution as compared with the total plant requirements.

unit, led to a more general use of this type. This trend is still in evidence as attention is being directed to larger units. During the development period of these internal combustion engines, much was learned by the pioneers who sought to improve the design, and likewise the operation. This development period is still in evidence for attention is being directed to larger size units. An illustration of this is furnished by the following data for the first waste heat boiler on engine No. 8, installed in 1935.

Hours operated	7803
Per cent of time operated	89.2
Average K.W. generated/hr.	3480
Average boiler horse power/hr.	398
Average pounds of steam/K.W. hr.	3.45

During this period the engine operation was handicapped by lack of gas due to curtailed plant operations. Under normal conditions this unit operates on a 96 per cent basis. The first two scavenged and supercharged gas engine blowers operated 98.5 per cent during their first 2 years of service; in their ninth year these are still as reliable as during the start of operation.

Gas engines were first introduced at Lackawanna Steel Company about 1900. These were of the 2-cycle, double-acting, twin-cylinder type. Later developments brought 4-cycle units. The gas engine operation was beset with many difficulties in its earlier stages. Gas cleanliness was not fully appreciated. The abrasives from the partially cleaned gas caused excessive wear on cylinders, made valves stick, and closed ports. These conditions no longer exist as blast furnace gas now contains less than 1 grain of dust per 100 cu. ft.

Bethlehem gas engines, designed and made locally have been in operation since 1909. The first units were of the 4-cycle, double-acting, twin-cylinder type, driving 1500 kw. D.C. generators at 150 r.p.m. They were in service until 1927, when our power requirements no longer needed this large block of direct current power.

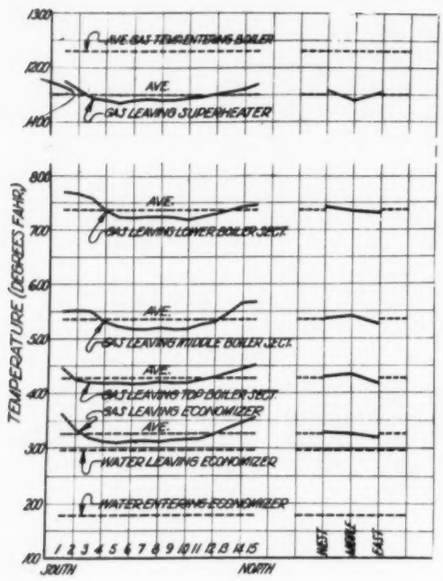


Figure 3—No. 8 gas engine waste heat boiler—temperature traverse.

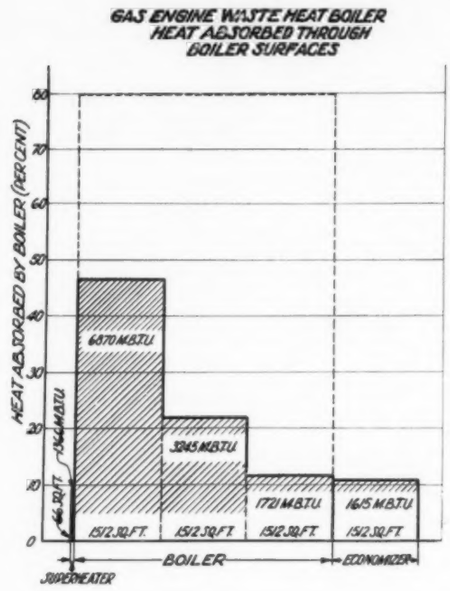


Figure 4—Gas engine waste heat boiler. Heat absorbed through boiler surfaces.

TABLE I—GAS ENGINE WASTE HEAT BOILERS COMPARISON OF HEATING SURFACES

	F.T. Boiler F.T. Econ.		F.T. Boiler W.T. Econ.		2 Drum V.W.T. B W.T. Econ.		C.D.W.T. B W.T. Econ.		C.D.W.T. B W.T. Econ.		C.D.W.T. B W.T. Econ.	
	Boiler	Econ.	Boiler	Econ.	Boiler	Econ.	Boiler	Econ.	Boiler	Econ.	Boiler	Econ.
Tubes:												
Number	368	249	435	64	520	288	528	192	216	72	200	60
Size	2″	2″	2″	2″	2″	2″	2″	2″	2″	2″	2″	2″
Length	19½′	13½′	17′	7′	14′	7½′	11′	11′	7′	7′	7′	7′
Total Length	7176′	3362′	7395′	448′	7280′	2160′	5808′	2112′	1512′	504′	1400′	420′
Area (sq. ft.):												
Dry Side	3280	1540	3385	1344	3800	1131	3040	1107	4536	1512	4200	1260
Total	4820		4729		4931		4147		6048		5460	
Wet Side	3746	1760	3850	205	3340	972	2660	970	692	231	641	192
Total	5506		4055		4312		3630		923		833	
Evap. #/hr./sq. ft.:												
1. Dry Side	2.49		2.54		2.44		2.90		1.98		2.20	
2. Wet Side	2.17		2.95		2.78		3.31		13.0		14.40	
Overall Dimensions:												
Length	43′–0″		38′–0″		31′–0″		16′–0″		11′–9″		10′–7″	
Width	9′–0″		10′–0″		9′–0″		10′–0″		8′–0″		7′–8″	
Heighth	18′–0″		16′–6″		23′–10″		23′–0″		21′–0″		20′–7″	
Floor Area	387 ft²		380 ft²		279 ft²		160 ft²		94 ft²		84 ft²	
Gas Passage:	Two Pass		Two Pass		Two Pass		Two Pass		Single Pass		Single Pass	
Pressure Drop	3.7″ H_2O		6.0″ H_2O		6.4″ H_2O		9.0″ H_2O		4.0″ H_2O		8.0″ H_2O	

The gas engine blowers have been in operation since 1909 and are still functioning. We have supplemented these older units with four 4-cycle, double-acting, two-crank, tandem scavenged and super charged engines; as previously stated these operate 98.5 percent of the time. With a 60 lb. M.E.P., they are rated at 5000 hp. or 3560 kw., for a 96 per cent electrical efficiency.

The improvement in the mechanical operation of the gas engine led to the development of a satisfactory type of waste heat boiler. The European practice was to use fire tube boilers and economizers. This contributed to lower installation costs, and was in line with boiler development of the time.

At Bethlehem it was first thought to install fire tubular boilers and economizers according to established practice. As clean flue gases contribute to satisfactory operation a final flue gas temperature of 350 deg. F. and a feed water temperature of 200 deg. F. were decided upon. By so doing the use of the fire tube economizer was eliminated. Following the results obtained, a comprehensive study was made of various types of boilers, as shown in Table I.

Due to the law calorific value of blast furnace gas, steel plants have been slow to utilize it for other than stove and boiler purposes. A 500-ton furnace will supply about 2,000,000 cu. ft. of gas per hour above its own requirements. The steam load in steel plants with power units is very high, and the natural procedure is, therefore, to use this gas for boiler purposes. However, with increasing fuel prices the tendency is to use blast furnace gas in gas engines and metallurgical furnaces before using it under boilers. Waste heat boilers should be applied to all large gas engines and to metallurgical furnaces if the return warrants the installation.

The amount of steam which can be generated in a waste heat boiler when supplied with a definite quantity of gas at a given temperature depends on the size of the boiler and the allowable draft loss. In practice, the theoretical limit of recovery is the heat in the gases between the temperature at which they leave the engine and the temperature of saturated steam at the desired operating pressure, or the temperature of the feed water if economizers are provided. It is not practicable, however, to build a boiler that even closely approaches this condition, but it is economically feasible to design a boiler with an efficiency up to 70 per cent if it is permissible to build up a draft loss of about 4 in. of water or higher through the boiler.

The flue gases enter the waste heat boiler at 1200 deg. F. and leave at 350 deg. Further recovery, in the form of hot water, can be made from this flue temperature but local conditions determine whether such recovery is justifiable.

The fuel distribution sheet, Figure 2, indicates the value of gas engine waste heat boilers, compared with the total plant load. Successful operation of the units governs the amount of boiler fuel purchased. Table II gives the heat balance of the gas engine and waste heat boiler. A study of the boilers, Figures 3, 4 and 5

TABLE II

HEAT BALANCE OF BETHLEHEM 4000 KW. GAS ENGINE AND WASTE HEAT BOILER UNIT

	M BTU	%
1. Net Power Generation	12,683	27.16
2. Steam Generation	13,983	29.94
3. Loss to Cooling Water	12,040	25.78
4. Loss to Boiler Blowdown	913	1.95
5. Loss to Sensible Heat in Stack Gas	4,691	10.04
6. Loss to CO in Stack Gas		0.00
7. Radiation and Unaccounted for	2,398	5.13
	46,708	100.00

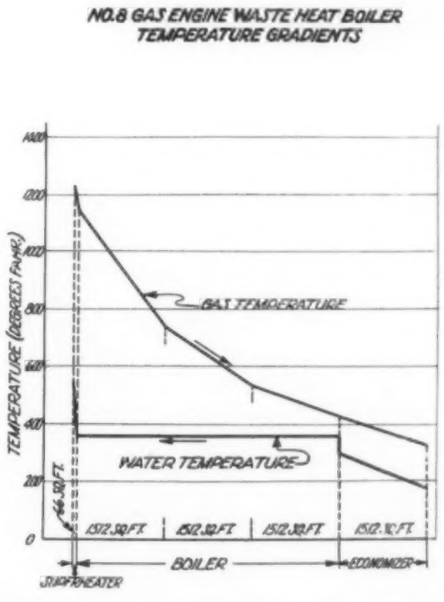
HEAT BALANCE OF BOILER

1. Steam Generation	13,983	70.51
2. Loss to Blowdown	913	4.60
3. Loss to Sensible Heat in Stack Gas	4,691	23.66
4. Radiation and Unaccounted for	243	1.23
	19,830	100.00

ENGINE HEAT BALANCE

1. Net Power Generation	12,683	47.18
2. Loss to Cooling Water	12,040	44.80
3. Radiation, Mech. and Elec. Losses	2,155	8.02
	26,878	100.00

Figure 5—No. 8 gas engine waste heat boiler—temperature gradients.



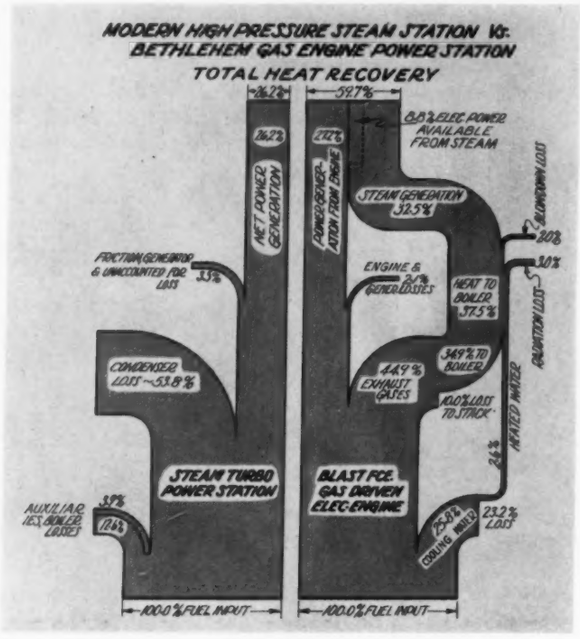


Figure 6—Modern high pressure steam station compared to Bethlehem gas engine power station with relation to fuel input against total heat recovery.

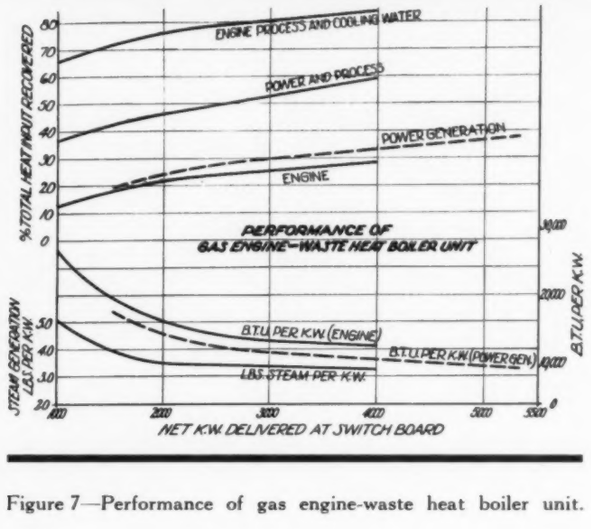
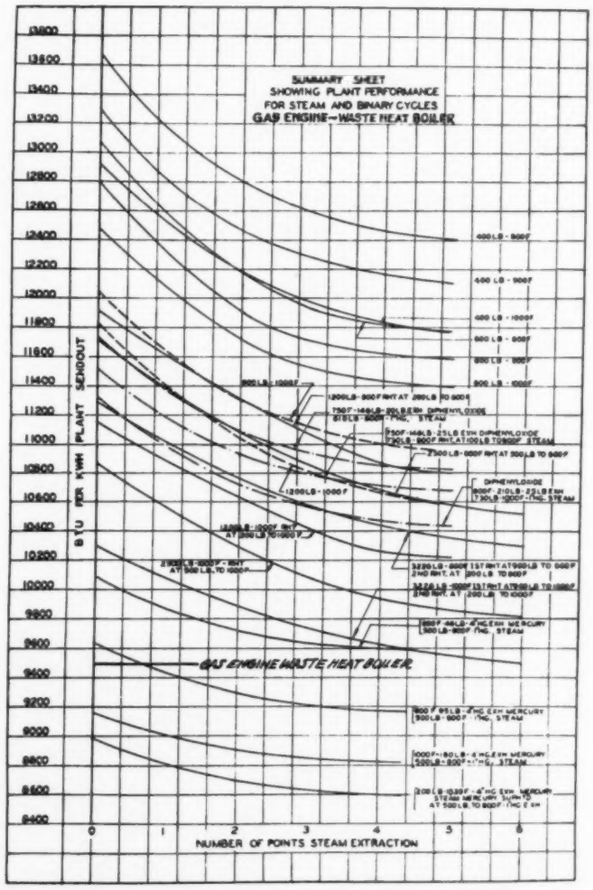


Figure 7—Performance of gas engine-waste heat boiler unit.

Figure 8—Summary sheet showing plant performance for steam and binary cycles, gas engine waste heat boiler.

(Taken from transactions of American Society of Mechanical Engineers, Vol. 56, No. 10, October, 1934, page 763: "High-Pressure Steam and Binary Cycles as a Means of Improving Power Station Efficiency", by Gustaf A. Gaffert.)


SUMMARY SHEET
SHOWING PLANT PERFORMANCE
FOR STEAM AND BINARY CYCLES
GAS ENGINE—WASTE HEAT BOILER
BTU PER K.W.H. PLANT SENDOUT
GAS ENGINE WASTE HEAT BOILER
NUMBER OF POINTS STEAM EXTRACTION

shows a uniform drop in flue temperatures through the boiler. In a well designed boiler the heat absorbed follows a definite curve. From the charts it is seen that additional heating surface is justified; the temperature gradient also shows the practical limitation of the boiler surface.

Much progress in power plant economy has been made during the past ten years. This has principally been accomplished by resorting to various combinations of regenerative feed water heating, steam reheating and extraction of heat from the flue gas by means of economizers and air preheaters. These systems have high steam pressures and temperatures. In addition there are the binary cycles, mercury-steam, diphenyloxide-steam, zinc-ammonium chloride, and aluminum bromide; of these the mercury-steam is best known in this country (See Figures 6, 7 and 8).

All these highly improved power schemes are excellent, but with their complications the simpler gas engine and waste heat boiler combination is more advantageous with a load of the type found in the steel industry.

As an illustration, a comparison has been made between the present operating gas engine units, equipped with waste heat boilers, and a relatively good turbine operation in a Mid-Western steel plant, and with a unit of unusually high efficiency as can be obtained in turbine with 1250 lbs. steam pressure and 880 deg. temperature. (Table III.)

The present gas engine waste heat boiler unit has demonstrated clearly what operating results are attainable. For further improvements it will be necessary to go to larger units. As far as advantages are concerned, units of twice the present size are comparable with larger turbine units. Such a unit should be able to generate on the shaft the equivalent of 8000 kw., with an additional 2600 kw. from waste heat boiler steam, and is well adapted to a steel plant with an electric load of 20,000 kw. or more. For a smaller power load the present unit is ample.

In Europe there are gas engine units generating in excess of 7000 kw., and gas engine blowers delivering 135,000 cu. ft. of 15.6 lb. air per minute. Size for size these are more efficient than the present size units, because mechanical losses and losses through jacket water and radiation are smaller.

Summarizing, in steel plant operation, the Bethlehem gas engine that has been in operation for the past 20 years, but completely renovated, has been able to compete with the modern turbine units. Furthermore, application of waste heat boilers has reduced operating cost to the extent where such a combination is the only logical one. As the size of the gas engine increases, the advantage becomes still greater. Compared with a turbine station, the gas engine-waste heat boiler system requires only half the amount of fuel, for the same power output, releasing the remaining half for metallurgical furnaces. Normally, this advantage is still further enhanced due to the fact that a higher priced fuel is used for metallurgical furnaces.

The final analysis of any scheme is the ultimate cost to the producer. The combination gas engine and waste heat boiler can meet the initial cost of installation and give a lower operating cost.

Due to the higher thermal efficiency of this combination, its advantage becomes greater with increasing price of fuel.

TABLE III
COMPARISON OF GAS ENGINE WASTE HEAT BOILER UNIT WITH MODERN STEAM UNITS IN STEEL PLANT

	Blast Fce. Gas Eng. Unit		Actual Oper. Turbo Unit 275# 615° Temp.		Theo. Steam Unit 1250# & 880° Temp.	
		Totals		Totals		Totals
General Plant Requirements:						
Total Iron Produced (Tons)	—	50,000	—	50,000	—	50,000
Power Generated (KWH)	—	14,000,000	—	14,000,000	—	14,000,000
Steam Req. for Process (Lbs.)	—	62,600,000	—	62,600,000	—	62,600,000
Gas Engine Set-up:						
Total Waste Heat Steam (Lbs.)	—	62,600,000	—	—	—	—
B.F. Gas Req. (100 BTU/cu. ft.)						
Per KW Generated	126	1,764,000,000	—	—	—	—
Per Ton of Iron Blown	13500	675,000,000	—	—	—	—
Turbo Set-up:						
Req. for Turbo Generators:						
Lbs. Steam/KWH	—	—	13	181,054,000	11.87	166,000,000
Cu. Ft. B.F. Gas/KWH	—	—	206	2,880,000,000	201	2,820,000,000
% Bled at 160 Lbs. for Plant Process	—	—	—	—	38	63,000,000
Req. for Turbo Blowers:						
Lbs. Steam/Ton Iron	—	—	1291	64,530,000	935	46,700,000
Cu. Ft. Gas/Ton Iron	—	—	20570	1,027,000,000	16000	800,000,000
Total Steam Generated	—	62,600,000	—	308,184,000	—	212,750,000
Steam Generated for Process	—	—	—	62,600,000	—	—
Cu. Ft. Gas Req./Lbs. Steam	—	—	15.9	993,000,000	—	—
% Total Heat Input Received by Elec. Power and Process Steam						
Unit	—	59.7	—	26.2	—	45.0
Total B.F. Gas Required	100%	2,439,000,000	201%	4,900,000,000	148.5%	3,620,000,000
Bituminous Coal Equiv. in Tons	—	8,060	—	16,200	—	12,000
Loss per year at $5.00/ton of coal Equiv.	—	—	—	$489,800	—	$236,400

LOW VOLTAGE SYSTEMS IN STEEL PLANTS

By D. C. NELSON
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Abstract of paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ IN the early days of the electrification of the steel industry, not much study was necessary on the low voltage distribution system, due to the small amount of motorized auxiliaries, and not much study was put on it; as anyone who is familiar with the early industrial installation will have to admit, most of the time and money was spent on the layout and arrangement of the mill equipment, while the necessary power lines were left to the mill electrician to be installed in any manner he could get them up and with the least possible cost and time.

However, today in a modern electrified steel mill with the total connected H.P. in auxiliary equipment

D. C. NELSON

sometimes exceeding the main drive H.P. capacity and with the additional responsibility of maintaining continuity of service on auxiliary drives equally as important as that of main drive equipment, in the interest of true economy—which involves over-all yearly cost for the entire plant, field charges plus operating expense—the steel plant management should realize that well planned and installed low voltage distribution systems pay dividends and that, by trying to save money on an original installation, by installation of inadequate units, using cheap cable, labor, and material that this only raises the over-all plant operating cost, due to the many ills that come about from a poorly planned and installed distribution system—such as circuit outages, excessive voltage drop, curtailment of production due to breakdown, by not having an adequate stand by unit, or by not having arranged for tie lines between distributing points.

No doubt the above facts have been brought forcibly to the attention of many a steel plant electrical superintendent by his daily delay reports and his operation cost sheet.

SYSTEM STUDY

The first step in any such study is a careful survey and analysis of the load requirements. The object of the load study is to determine the magnitude and also the distribution of load throughout the plant.

Some differences in economy are due to the physical shape of a plant, quite a few of our steel plants have grown up along river banks, and are composed of very long and narrow areas which makes centralization of low voltage distribution and location of substations more difficult than for a more compact area.

Not having any previous records of existing plants, with complete meter readings, etc., it is necessary to resort to the installed horsepower. Having arrived at the total horsepower capacity for each building or section, a factor must be applied to obtain the equivalent average load at the station bus with the plant operating at full production. This factor will depend on the diversity of utilization or, more precisely, on how much of the installed power will operate simultaneously. This factor is an extremely important one as its correct evaluation can contribute more than any other to determine the necessary capacity of conversion equipment to install, and the correct size of feeder circuits for distribution efficiency.

To evaluate this "Demand" or "Simultaneity" factor very closely is very difficult and requires experience and familiarity with the individual processes which make up total in steel mill production.

It is always very desirable to establish this factor for the particular type of plant under consideration by actual average load measurements at the existing

station. The chart should cover at least a full day and a time when the plant is operating at maximum production capacity in all departments. Allowance to the factor obtained from the chart readings would have to be made to offset subnormal production and to allow for future growth of the plant. Also if readings are taken in summer, allowance should be made for winter load conditions.

From the above statements you can readily see the value and help to any steel mill electrical man, by discussion from the different steel mill plants as to the actual demand factor required for the different types of mills, for their auxiliary drives.

In general in laying out the distribution system for a steel mill, several schemes should be considered. As there is such a wide variety of products covered by steel mill installations, it is not feasible to set up a hard and fast rule to follow as each different plant or mill constitutes a problem in itself.

To make an economic study, the following are some of the things to be done and considered:

A. DETERMINATION OF LOADS AND LOAD CENTERS

1. Survey and analysis of demand requirements.
2. Large or small conversion units.
3. Standardization on size of unit.
4. Spare units or portable substations.
5. Availability of station sites.

B. CHARACTERIZATION OF SYSTEMS

1. Automatic.
2. Semi-automatic.
3. Manual.
4. Regulation.
5. Consideration of changes and additions.
6. Efficiency of equipment under requirements.
7. Power factor relation.

C. TYPE OF EQUIPMENT

1. Machines:
   a. Synchronous Motor Generators.
   b. Induction Motor Generators.
   c. Synchronous Converters.
   d. Mercury Arc Rectifiers.

In choosing the kind of machine, consider:

Installed cost.
Space requirements.
Efficiency.
Power factor conditions.
Parallel operations.
Safety features.
Reliability.
Character and amount of maintenance.

2. Transformers—Consideration should be given to:
   a. Installed cost.
   b. Space requirements—Single or three-phase.
   c. Efficiency.
   d. Fire hazard—Location—Type of cooling.
   e. Advantages of connections.
   f. Advantages of installing 2 single-phase open-delta connection of larger size to give approximate same capacity as 3 single-phase connected in closed delta.
   g. Standardization in size and characteristics for interchangeability purposes, spare units, and parallel operation.

D. FEEDER CIRCUITS

1. A-C Feeders:
   a. Manual, Magnetic, or Automatic.
   b. Safety enclosed truck type or open type fixed units.
   c. Metering.
   d. Circuit breaker—2 or 3 pole.
   e. Knife switch—any—2 or 3 pole.
   f. Size—Single or multiple feeds.
   g. Standardization.
   h. Safety features.

2. D-C Feeders:
   a. Manual, Magnetic, or Automatic.
   b. Safety enclosed truck type or open type fixed units.
   c. Metering.
   d. Circuit breaker—1 or 2 pole.
   e. Knife switches—any—1 or 2 pole.
   f. Size—Single or multiple feeds.
   g. Standardization.
   h. Safety features.

3. Feeder Circuits:
   a. Overhead or underground.
   b. Bus or cable.
   c. Arranged for ease in isolating faults, least interference from other circuits, building extensions, and accessibility for repairs and extensions.
   d. Protection against mill operating hazards.
   e. Ample capacity for distribution of loads and with margin of safety for additions of new loads or redistribution of loads.
   f. Distribution efficiency—load voltage conditions necessary.
   g. Interconnection of feeders.
   h. Completely sectionalized—One side of system solidly grounded.

E. DECISION BASED ON COMBINED STUDY OF PRACTICAL CONSIDERATIONS AND TRUE ECONOMY

In the paper to be presented, illustrations of single line diagrams of recent hot and cold mill installations will be shown.

TURBINE DEVELOPMENTS

Their Application in the Steel Industry

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PHILADELPHIA, PA.

Paper presented before the Pittsburgh District Section A. I. & S. E., November 21, 1936.

▲ WE have been asked to prepare this discussion on the subject of "Recent Turbine Developments with Special Reference to Applications in the Steel Industry." I assume that you are interested in some of the present-day trends in the steam turbine field, particularly in those problems that relate to metallurgical developments and their application, as well as developments toward greater reliability in operation, and some of the special problems associated with turbine application in the power plants of your mills.

DEVELOPMENTS IN STEAM PRESSURES AND TEMPERATURES

Many of the most important problems encountered in the development of steam turbines have been those associated with the increase in throttle steam pressures and temperatures, and of vacuum, along with the increase in maximum unit capacities. Figure 1 shows a general picture of the rate of change of these factors over the past years as far as my Company is concerned.

In order to understand the background against which the pressure, temperature, and vacuum increases have been made, it is worthwhile to consider for a moment the normal thermal cycle of a condensing turbine plant. Water is supplied to the boiler at a temperature which depends upon the arrangement of plant auxiliaries, and usually is at least 100°F below the saturation temperature at boiler pressure. Heat is added to increase the temperature to the boiling point, then to evaporate the water at constant temperature, and finally to superheat the steam.

In passing through a perfect turbine, steam would expand at constant entropy. In the actual machine, however, there is a continuous increase in entropy due to losses in the conversion of heat into work, with consequent reheating of the steam. After expanding to a vacuum of 29 in referrence to a 30 in barometer, there is still a very substantial portion of the original heat remaining in the steam, the exact amount depending upon the initial steam pressure and temperature and the turbine efficiency, but of the order of 950 Btu/lb. This heat is rejected to the condenser and has to be replaced by the boiler. Steam extraction for feed water heating permits utilization of the heat of condensation of the bled steam, but with the best regenerative feed heating cycle, the thermal efficiency of the condensing turbine and feed heating system will seldom exceed 35%.

This characteristic of the condensing steam cycle furnishes the principal incentive to increase the energy available from the expansion of each pound of steam, thus making the rejected heat of the condensed steam a smaller part of the whole. The same consideration dictates the use of non-condensing turbines whenever the exhaust steam can be used for process purposes, where the heat in the exhaust steam is not lost. As a compromise between the condensing and non-condensing turbine, there is the automatic extraction turbine supplying process steam demand, along with a condensing exhaust end.

The available energy in each pound of steam may be increased by raising either or both the steam pressure and temperature, or increasing the vacuum at which it is rejected to the condenser. Condenser development has proceeded in parallel with that of the turbine to a point where vacua closely approaching the absolute limit are attainable, and selection of the proper condensing equipment is now largely an economic study based upon average load, cost of fuel, water conditions, pumping power, and space. Present-day high vacua have had an important influence on condensing turbine design, as is obvious when we consider that from common turbine throttle conditions of pressure and temperature, steam expands to from 400 to 600 times by the time it reaches the turbine exhaust, and the low pressure blades must be proportioned to utilize this very large steam volume efficiently. It may be said that stress limitations which determine the maximum safe dimensions of low pressure blades, also determine the practical limiting capacity rating of high vacuum condensing turbines, and greater capacity can then only be obtained by compounding the turbine elements to increase the number of exhaust blade rows, or by decreasing the speed of rotation of the turbine.

Steam pressures and temperatures have increased more or less continuously for many years, and there is no reason to assume that the ultimate has been reached, although it is clear that metallurgical develop-

ments are necessary before there can be much further increase in steam temperature.

For some years turbines have been operating with 1200 lb/in²g at the throttle. Recent activity in superposition of turbines in existing plants has greatly increased the number of such units. High steam pressures in themselves do not present a very difficult problem in turbine design.

The records show the 1200 lb. turbines built prior to the last year or so were designed to operate with steam at 750°F maximum. Recently, steam temperatures have been stepped up to 850°F and finally to 950°F maximum for regular commercial operation. We are of the opinion that for the time being it is advisable to stop at 925°F normal steam temperature, allowing swings to 950°F maximum, until sufficient operating experience has been obtained to justify a further advance into regions in which little is now known. It is obvious that satisfactory performance of power generating equipment, both from the boiler and turbine standpoints, can be expected only if the characteristics of the materials used under stress at high temperature can be predicted with reasonable accuracy. The incentive for increase in steam temperature is particularly great, since it results not only in greater available energy from the expansion of each pound of steam, starting from a given pressure, but also decreases the rate of deterioration of low pressure blading due to moisture erosion, because there is less moisture present.

It has long been known that the materials in common use show more or less reduction in their physical characteristics as the service temperature is increased. To a certain extent this can be taken care of by designing for correspondingly reduced stresses at the higher temperatures. On this basis, satisfactory turbines have been built for steam temperatures up to 850°F, using a good grade of 0.35 carbon steel casting and forging for the casing and rotor. One of these turbines is shown by Figure 2. This is an 18,000 kw, 3600 rpm, non-

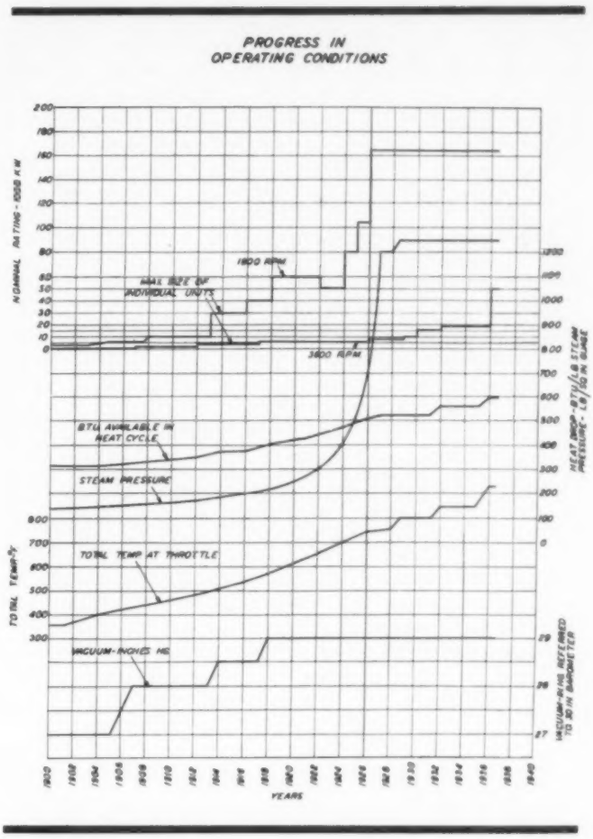
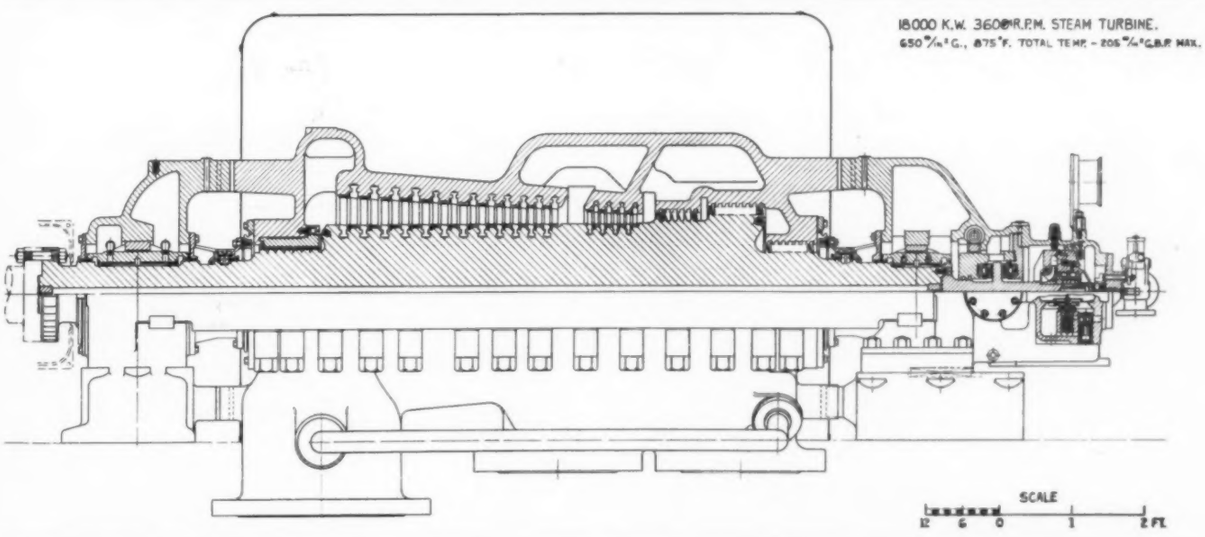

PROGRESS IN
OPERATING CONDITIONS
NOMINAL RATING - 1000 K.W.
1800 RPM
MAX. SIZE OF INDIVIDUAL UNITS
3600 RPM
BTU AVAILABLE IN HEAT CYCLE
STEAM PRESSURE
TOTAL TEMP AT THROTTLE
VACUUM - INCHES HG.
HEAT DROP - BTU/LB STEAM PRESSURE - LB/SQ IN GAUGE
VACUUM - IN HG REFERRED TO 30 IN BAROMETER
TOTAL TEMP °F
YEARS

Figure 1—General picture of the rate of change in throttle steam pressures and temperatures, and of vacuum, along with the increase in maximum unit capacities.

Figure 2—18,000 KW, 3600 rpm, non-condensing superposition turbine operating with steam at 650 lb/in²g at 825-850 F, and exhausts at pressures up to 200 lb/in²g as a minimum.



condensing superposition turbine operating with steam at 650 lb/in²g at 825-850°F, and exhausts at pressures up to 200 lb/in²g as a maximum. A second turbine using carbon steels at high temperature, shown in Figure 3, is rated 165,000 kw at 1800 rpm. This turbine receives steam at 400 lb/in²g at 825-850°F.

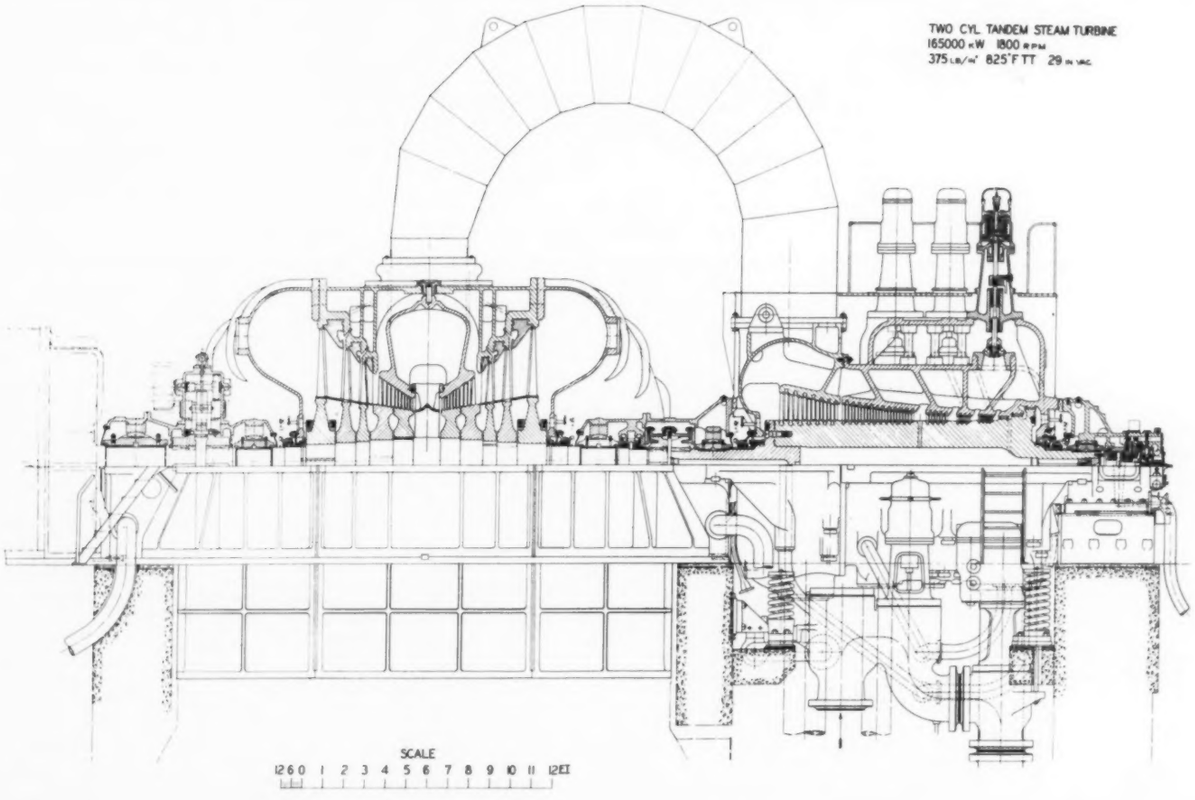
The practice of increasing casing wall thickness to reduce stress at high temperature cannot be carried on indefinitely, however, because of the very marked decrease in allowable stress around 900°F, which would result in massive structures in which the thick wall temperature stresses and corresponding distortions would be prohibitive under conditions of unequal and rapidly changing temperatures. At this point we become dependent upon the development of alloy steels having improved high temperature physical characteristics.

In recent years another phase of the high temperature design problem has been recognized, this being the phenomena of "creep" or "plastic flow". This matter is now the subject of intensive research by many investigators. "Creep" is a name applied to the slow growth, or plastic yielding, of material under stress at high temperature. There is no known "creep limit", or temperature below which creep does not exist, but it is known to proceed at a rapidly increasing rate for ordinary steels as temperatures increase above 800°F. Specific data on the subject is difficult and costly to obtain, as it is essentially a long-time phenomena which requires extreme care in both the control of the test equipment and in the interpretation of the results obtained. The history of the thermal treatment of a sample prior to test apparently has a marked influence upon its behavior on test. Naturally ,there have been many attempts made to interpret short-time creep tests in order to extrapolate to long periods, but as yet none of the proposed methods has been generally accepted.

Investigations have shown that a carbon molybdenum alloy is distinctly better than 0.35 carbon steel in creep properties, the improvement being such that the carbon-molybdenum at 900-950°F is comparable with carbon steel at 800-850°F. The carbon molybdenum steel referred to contains 0.43 carbon, 0.40-0.60 manganese, 2.5 nickel, 0.30-0.60 chromium, 0.20 molybdenum, and traces of phosphorus and sulphur.

Creep investigations have also shown that at 850°F the time rate of creep for 0.35 carbon steel doubles for only 12°F increase of temperature. One obvious conclusion that can be drawn from the information at hand is that it is very desirable, when operating with steam at 850°F and above, to provide the best possible

Figure 3—Turbine using carbon steels, rated 165000 KW at 1800 RPM., this turbine receives steam at 400 lb/in²g at 825-850 F.



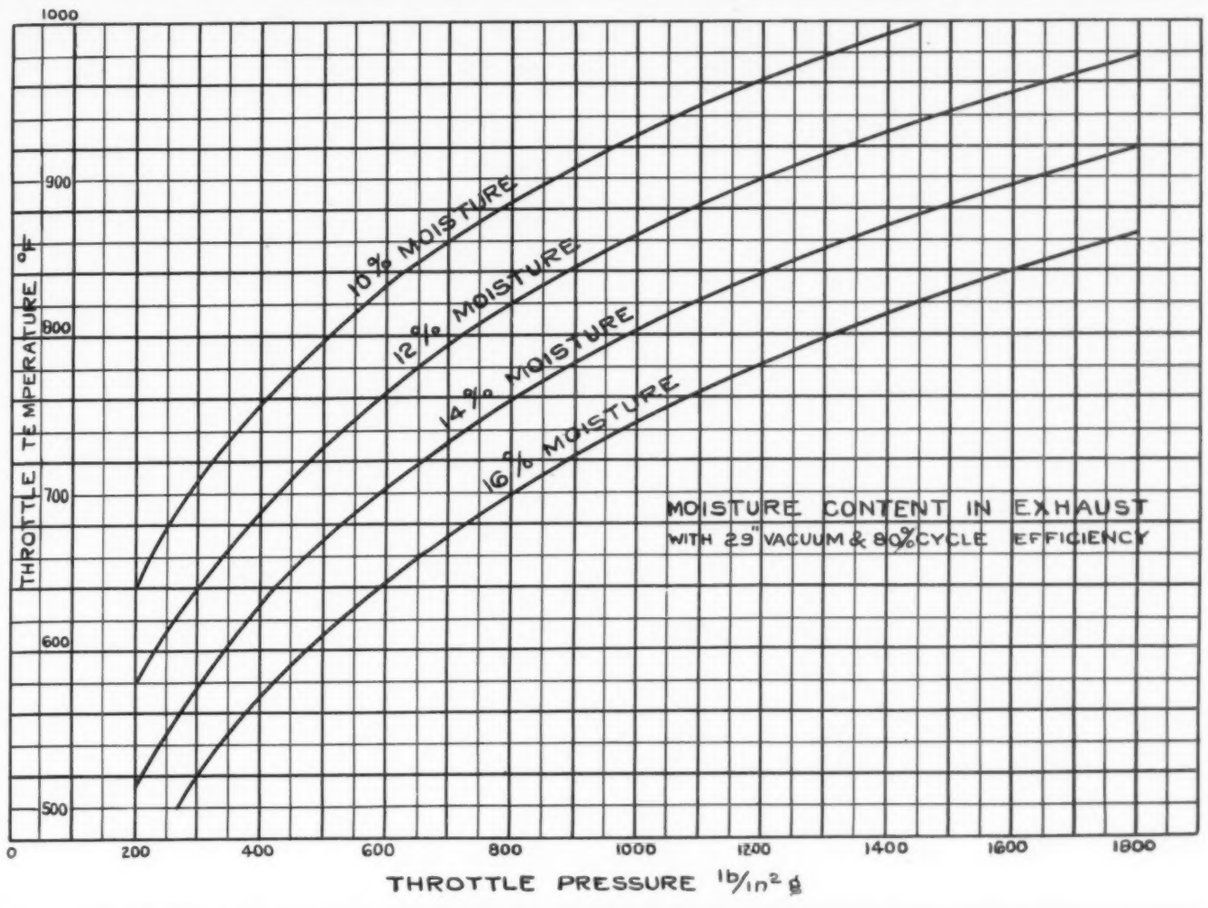


Figure 4—Approximate percent exhaust moisture content for various inlet pressures and temperatures, assuming 80% turbine efficiency on the Rankine cycle basis and 29 inch in vacuum.

superheat control equipment in the boiler in order to insure the most satisfactory performance of superheater tubes, piping, flanged joints, and turbine over the full range of capacity.

In the exhaust end of condensing turbines the steam will have been expanded to below its saturation point and will contain a certain amount of moisture. These drops of water, when they first form, will be extremely small, but will increase in size as each drop forms the nucleus for further condensation. The mass of a drop of water is about 600 times that of the corresponding volume of steam at high vacuum. A drop of water is incapable of doing any useful work as it passes through the blading, and, in fact, absorbs considerable energy from the steam which must supply the drag necessary to carry the water along. Because of the great difference in mass under high vacua, the water particles acquire only a relatively low velocity from the steam, and, as a result, they strike the back of the inlet edge of the rotating blade, producing quite an effective braking effect.

A more important consideration, however, is the fact that the impact of the moisture particles causes erosion of the blade material. The impact stress is a function of the speed with which the blade is moving and also of the density of the steam surrounding the moisture particle. At a given vacuum, the rate of erosion is, therefore, a function of the blade speed, the total weight of moisture passing through the blade path and of the erosion resistance of the blade material. High capacity condensing turbines require long, low pressure blading to provide the necessary steam passage for the large steam volumes involved, and this means high blade tip speeds. Turbines are in successful operation with blades having tip speeds of 1210 ft/s, and other turbines are now being built with blades up to 1250 ft/s tip speed. This corresponds to 14.2 miles per minute. As far as physical strength is concerned, standard corrosin-resisting steel blade material containing 12% chromium is well adapted to withstand the stresses necessarily associated with such blade speeds.

The more efficient the turbine, the greater is the portion of the available heat energy converted into work and, therefore, the greater is the moisture content of the exhaust steam. We, therefore, recommend choice of initial steam temperature, up to 925-950°F as a maximum, in order that the moisture content of the exhaust shall not exceed 12%. The curves in Figure 4 show the approximate percent exhaust moisture content for various inlet pressures and temperatures, as-

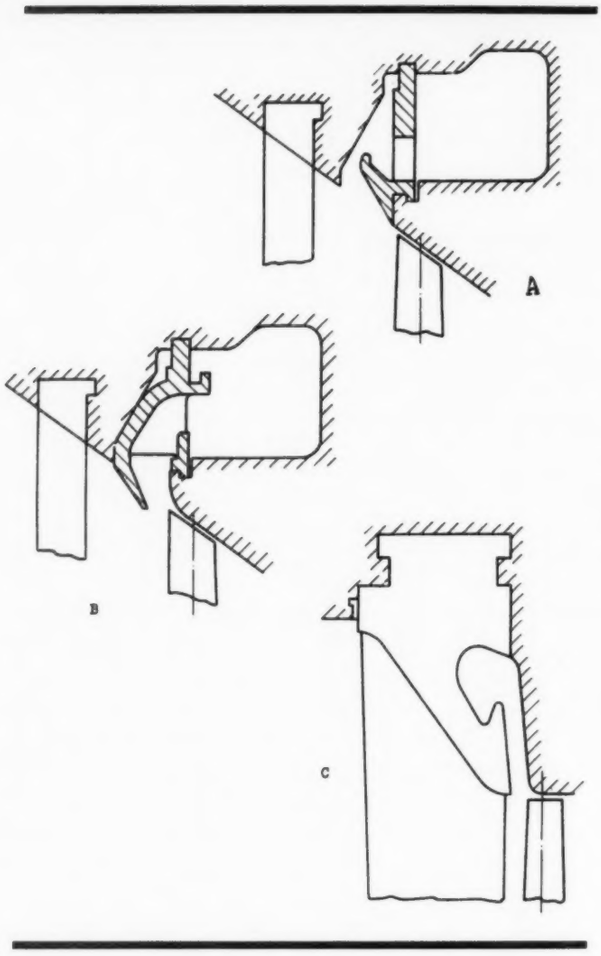


Figure 5—Arrangement for the extraction of part of the moisture through passages preceeding the last blade rows and opening directly into the condenser.

suming 80% turbine efficiency on the Rankine cycle basis and 29 inch in vacuum. These curves will change with the vacuum and with turbine efficiency, but are sufficient for present purposes of illustration. For the case shown, for instance, the steam temperature at the throttle should not be less than about 800°F for 650 lb/in²g throttle steam pressure, and not less than 900°F for 1200 lb/in²g at the throttle.

Arrangement is made for the extraction of part of the moisture through passage preceding the last blade rows and opening directly into the condenser. Typical arrangements are shown by Figure 5. Centrifugal force in the rotating blades tends to throw the moisture particles to the outer periphery. In experimental tests about 20% of the available moisture has been removed from the blade path through the water catchers. With the highest blade speeds moisture is removed from two points, that is, before the last, and also before the next-to-the-last moving blade row. In general, however, erosion of any importance is confined to the outer end of the last moving row only.

The third factor determining the rate of erosion, that is, the resistance offered by the blade material, has been found to be approximately proportional to the Brinell hardness of the material. This problem has been investigated both experimentally and in actual turbines. The experimental tests were made with plugs of various materials attached to the periphery of a small rotor which operates at very high speed, with small jets of water impinging on the rotating sample. The rate of erosion is very rapid in this test, and the comparative results are obtained by determining the loss in weight of the separate samples in any given time. Confirmation in actual operation has been obtained by using several different materials in the last blade row of certain large units. It has been found that material which is sufficiently hard to resist erosion to advantage is, at the same time, too brittle to withstand the vibratory stresses always present in large blading, but that a satisfactory solution is obtained by silver soldering a strip of stellite to the inlet edge of the last row. This strip is curved to fit the blade, is about ½ in. wide, and is applied to the outer end of the blade, extending about one-third the length of the blade. The Brinell hardness of stellite is 600-625 and the rate of erosion is about one-third that of the bare stainless steel which has a Brinell hardness of about 225. The most attractive part of this situation is the fact that it is practicable to replace these strips with new ones after they have eroded through, providing this is done before the blade itself has been too seriously eroded to form a satisfactory base for support.

LIMITING CAPACITY OF TURBINES

One of the important recent developments in steam turbines has been the increase in limiting capacity of 3600 rpm turbines driving 2-pole, 60-cycle generators. There are several incentives for such development, the most important perhaps being the desire to build turbine units of high speed, and, therefore, small physical dimensions for use with very high steam temperatures. The corresponding reduction in cylinder dimensions, particularly wall thickness, leads directly to reduced distortion and greater reliability. For condensing service, single-cylinder turbines are now available for about 20,000 kw rating at 3600 rpm and for about 80,000 kw at 1800 rpm. As previously mentioned, the exhaust blade annulus limits the practical rating for condensing units. Figure 6 shows in cross section a modern design of single-cylinder condensing unit for either 3600 or 1800 rpm. The principal dimensions of a 20,000 kw turbine at the higher speed would be about one-half those for an 80,000 kw, 1800 rpm unit.

In order to obtain greater capacity per unit, tandem compounding is adopted, resulting in an arrangement shown in Figure 7. You will recall that the cross section shown previously of the 165,000 kw turbine illustrated a similar tandem design. This arrangement is characterized by a single-flow, high pressure turbine element from which steam is exhausted through overhead pipes to a double-flow, low pressure element. Having two sets of exhaust blading, the limiting capacity will be 40,000-50,000 kw at 3600 rpm and about 200,000 kw at 1800 rpm. Again, the dimensions at the limiting ca-

pacity of the lower speed turbine will be appromimately twice those of the limiting capacity 3600 rpm unit.

SUPERPOSITION TURBINES

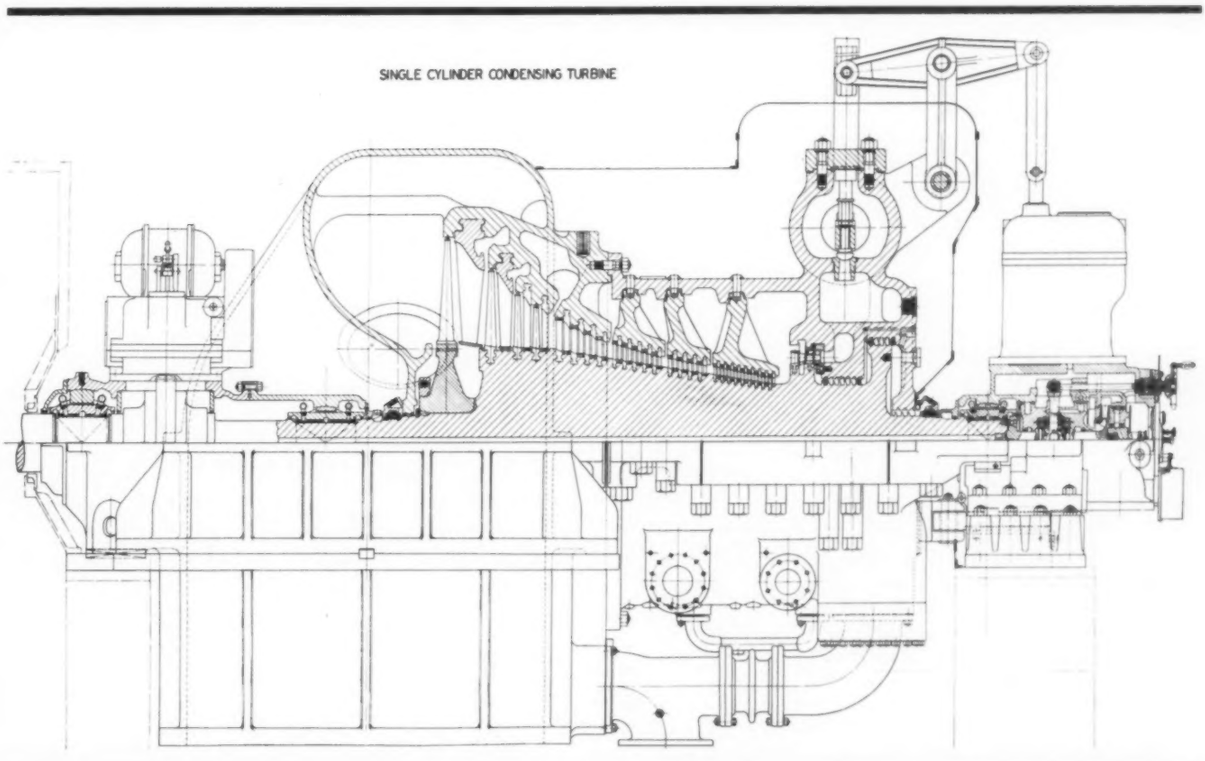
Ten years ago high pressure turbines were superposed over older condensing units in several power plants of this country. At that time, 1200 lb/in²g pressure was adopted with a temperature of about 725°F in the average case. These units were generally of about 10,000 kw capacity. As they were becoming established, the business depression put an end temporarily to any activity in the turbine market. The past year has seen a return to superposition turbines for many new applications, now with ratings up to 50,000 kw and steam temperature increased to above 900°F.

This plan offers a promising field for study to anyone now considering steam power plant extension. The gain in station thermal efficiency is considerable; however, it is not likely that the investment can be justified on the basis of improved efficiency alone, unless there is also a need for increased generating capacity. If interested in determining approximately what can be accomplished by superposition of high pressure turbines in any particular plant, you can do no better for preliminary survey than to use the estimating data given in a series of articles by Messrs. Zetterquist and Gove and appearing in the February, April, and June, 1935 issues of the Electric Journal. From these data you can obtain a fair idea of both the increase in plant capacity and the reduction in Btu consumprion per kilowatt hour generated.

Superposition of high pressure turbines means the installation of non-condensing units operating with steam at, say 1200 lb/in²g and exhausting into the older condensing turbines in the plant. The increment of power added to the plant is generated without rejection of heat to the condenser, meaning that the increment of power is produced for only about 4100 Btu/kwh, assuming 85% efficiency of the boiler. Just what effect this will have on the overall Btu rate of a particular plant will depend upon the original condition of the plant and upon the amount of superposition. In one case, the station Btu rate was reduced from 24,000 Btu/kwh to 14,400 Btu/kwh, and the plant capacity was increased 48%. It must not be inferred, however, that such a development is economically justified wherever an increase in capacity is needed, as this can only be determined after a detailed study of all circircumstances.

There is no low pressure blade limitation in these non-condensing units, therefore, they are built as single cylinder units up to the maximum capacity so far encountered. The exhaust pressure on superposed turbines is generally between 200 and 350 lb/in²g. A turbine of this type is now being built for operation at 1250 lb/in²g, 925°F temperature, exhausting at 340 lb/in²g, to pass 1,300,000 lb/h of steam when developing 50,000 kw load. The limiting capacity of this type of

Figure 6—A modern design of single-cylinder condensing unit for either 3600 or 1800 rpm.



turbine will be encountered in either the generator rating or in the steam flow. We believe steam flows up to 2,000,000 lb/h can be handled satisfactorily with designs now available. All of these turbines for high temperature and large steam flows require special care in design to insure uniform heating and unrestricted expansion of the cylinder.

Most of the condensing turbines over which new units have been superposed were built before the general adoption of the regenerative feed water heating cycle, and it is often not possible to modify them for extraction. Figure 8 shows diagrammatically the arrangement adopted in one case where a separate feed heating turbine is connected in tandem to the main superposition turbine. The boilers supply steam at 1200 lb/in²g, 900°F. The main turbine will pass approximately 1,000,000 lb/h of steam at full load and exhaust at 200 lb/in²g. About 85% of the exhaust steam is then used in condensing turbines. The other 15% of the exhaust steam is used for feed water heating, part of it directly in a 200-lb heater, and the remainder in 5-lb and 60-lb heaters after expansion in a separate turbine to these pressures. Leakage steam from the turbine glands is used in the atmospheric deaerating heater. The two turbine elements are arranged in tandem to drive a single, 50,000 kw, hydrogen-cooled generator at 3600 rpm. The main unit may be operated without the feed-heating element in service, if necessary. It will be evident from the diagram that the entire heat energy supplied to the system in the steam appears either as generator output, or in the form of heat in the steam to the old condensing units, or heat in the boiler feed water, with the exception of about 3% of the total which is consumed by the electrical and mechanical losses.

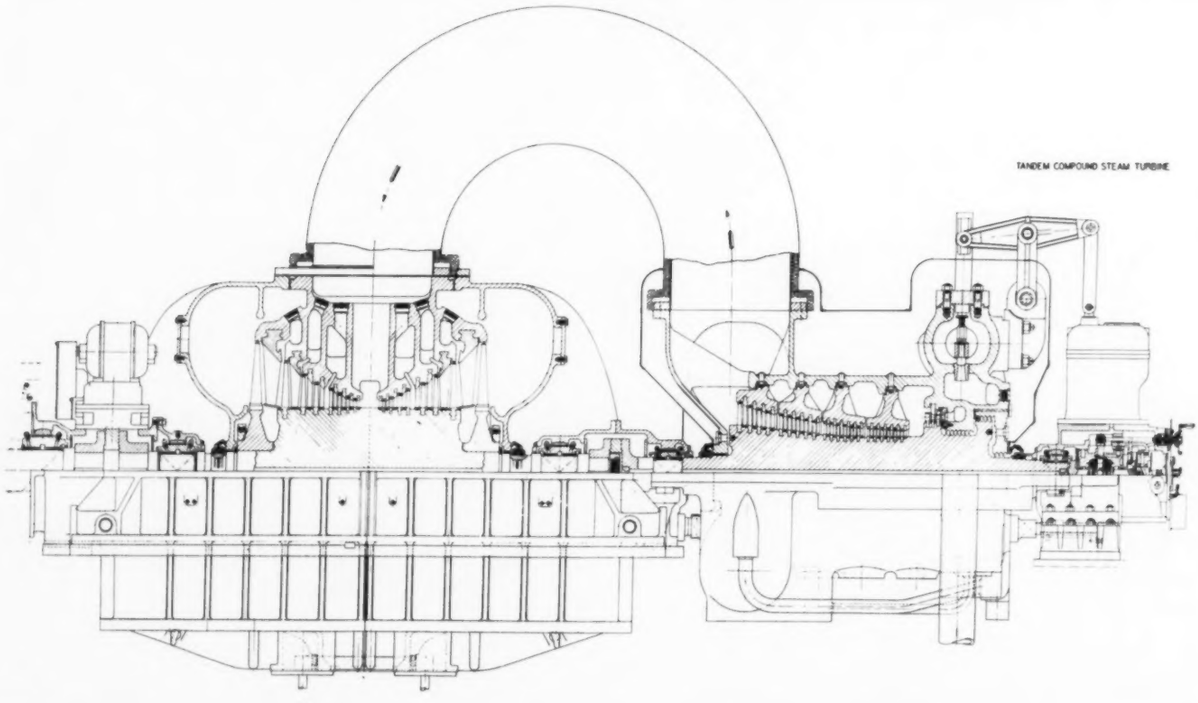
Steam to the main turbine is controlled by a speed responsive governor which, however, is normally also responsive to pressure in the 200-lb header so as to cause sufficient steam to be passed to maintain this 200-lb exhaust pressure at all times. Pressure in this line is important because of plant steam auxiliaries connected to it. Steam to the feed heating turbine is also under governor control, this governor responding to changes in the 5-lbg exhaust to the deaerating heater. If there is a variation in the quantity of condensate to this heater, the governor regulator will function to maintain the heater pressure practically constant to insure proper deaeration. Pressure in the intermediate heater will vary with steam flow, as in any non-automatic extraction system.

The general arrangement of this tandem, non-condensing turbine will be evident from the cross section shown by Figure 9.

SPECIAL PROBLEMS IN THE APPLICATION OF STEAM TURBINES TO STEEL MILL POWER PLANTS

Most of the steam turbine generator units applied to steel mill loads in the past have been in ratings of 10,000, 15,000 or 20,000 kw, occasionally with large overload ratings for short-time peak demands. There

Figure 7—Tandem compounding arrangement used to obtain greater capacity per unit.



appears now to be a trend toward larger individual units for this application. Also, most of the generating units have in the past been for 25-cycle power, which limits the rotative speed to 1500 rpm for 2-pole generators. Some of the more recent projects have been based upon 60-cycle generation, which is a very important development insofar as the turbine builder is concerned, as it will permit the use of 3600 rpm turbines with increased reliability for high steam temperature service. To date, the steel industry has been very conservative in the choice of steam pressures and temperatures, and this is not entirely without justification so long as 1500 rpm, 25-cycle units are involved.

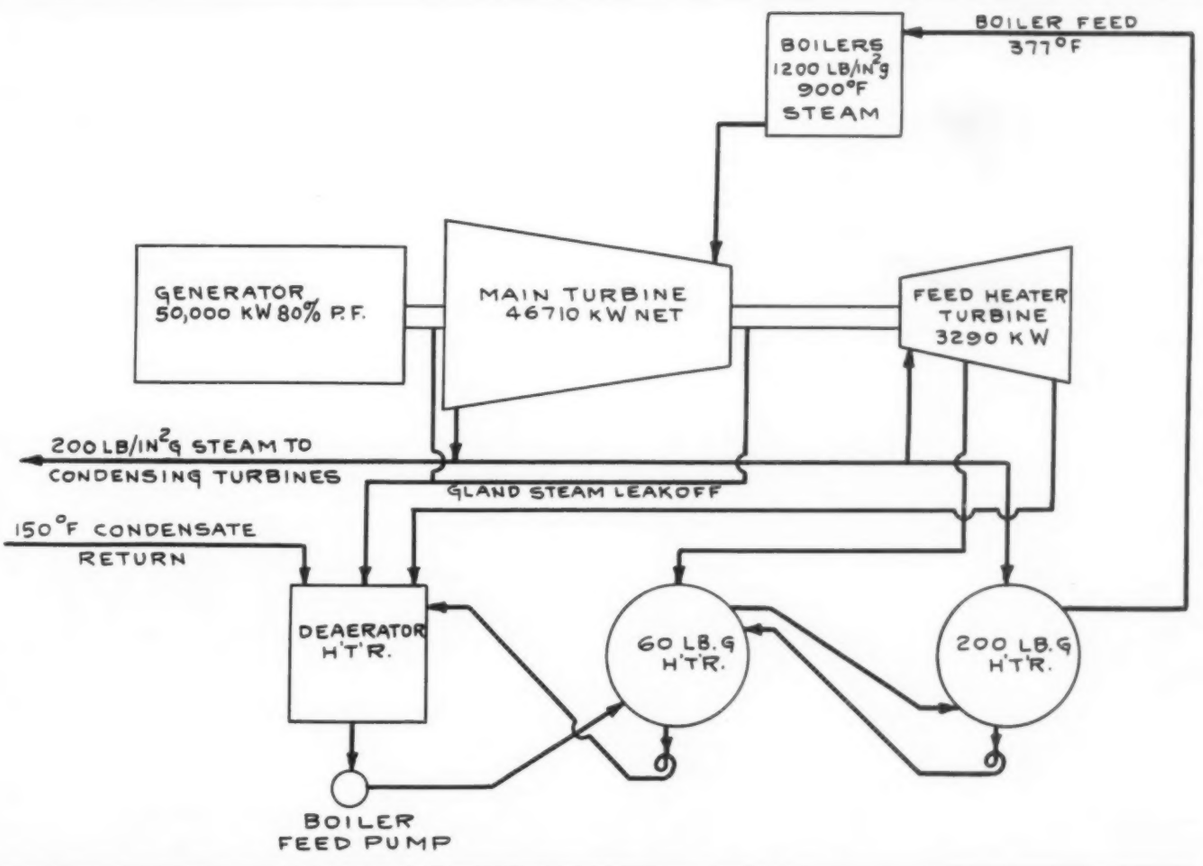
Since steam pressures have generally been in the 200-250-lb class, superposition of higher pressure and temperature units is likely to result in very large increments of station capacity and reduction of station heat rates. The favorable existing steam conditions combined with low-speed condensing turbines driving 25-cycle generators, makes it unnecessary to go beyond 650 lbs at 825°F to obtain sufficient advantages from superposition to deserve your careful consideration.

The most important problems characteristic of steam turbine application to steel mill power plants are probably those associated with control. These are found in connection with partial use of steam from waste heat boilers, as well as in the problem of control under the large and rapid swings of rolling mill load, either with or without the complication introduced by a combination of local and purchased power.

In some cases, turbines have been operated with steam supplied entirely from waste heat boilers, in which case fuel gas is generally not storable. Power demands and gas supply are not necessarily related, therefore, such turbines are often equipped with throttle steam pressure controls in order that the steam flow and unit power output will be regulated by the amount of steam available at any moment without regard to the total demand for power. Such units are, of course, backed up with turbines supplied with steam from solid fuel boilers which must supply the power demand remaining after all non-storable fuel is utilized. All that need be said on this subject is that developments made in turbine control systems in the past few years have given equipment far more sensitive and accurate than that used on older machines. This statement applies both to the pressure regulation available for waste heat steam pressure control, and also to the quality of governing available for the turbine using steam from the solid fuel boilers.

Satisfactory frequency control under rolling mill load requires a very sensitive and rapid turbine governor.

Figure 8—Arrangement adopted in one case where a separate feed heating turbine is connected in tandem to the main superposition turbine.



Practically all of the turbines manufactured by our Company and now installed in the power plants of steel mills have the familiar spring-loaded flyball governor, mechanically driven from the turbine shaft, controlling steam inlet valves through an oil relay system. Twelve years ago, development was started on a hydraulic control system using the change in pressure created by an impeller on the turbine shaft as the measure of change in speed. Several hundred such systems have since been applied, mostly on the industrial type turbine. Within the past few years, important developments have been made to increase sensitivity and power of the governor by interposing a hydraulic pressure amplifying device and redesigning for a minimum of friction.

Limitation of time does not permit describing this new control system in detail. It is sufficient to say that the desired improvement in quality of control has been obtained, demonstrated in the few installations now actually using the "transformer" governing system, and our confidence in it is shown by its general use on the many new units now under construction. As this governor was being designed, all conceivable pressure control arrangements were anticipated and built into the structure.

Some attention has been given to making the old flyball governing system more sensitive and rapid. This has resulted in working out a scheme by which one of the latest oil governing systems can be added to the valve gearing of existing turbines. The primary governing impulse for such a governor is obtained from an impeller driven by a synchronous motor connected to the system to be controlled. This special governor should have much closer speed regulation, together with greater sensitivity, than the original governor. It can also operate under influence of various load control devices for which the old flyball governor was not well adapted.

Electrical equipment has been developed for load control. One important application of this equipment is in a steel mill power plant having a purchased power tie line combined with a rolling mill load. It is important to avoid sudden wide swings on this tie line, from the standpoint of the utility in order to avoid regulation trouble, and to the purchaser, in order to avoid unnecessary peak demand charges. Under normal circumstances, a sudden increase in plant load resulting from a billet entering the mill, will cause frequency to drop and load will be picked up by the plant and by the tie line in approximately the ratio of their connected running capacity, assuming the speed regulation of the active governors is about the same. Thus, with the running capacity on the incoming power system nine times as great as that of the local plant, 90% of the load swing would fall on the tie line. The momentary value of the distribution of the swing would, of course, also depend upon relative electrical characteristics of the two sources of supply.

Load control equipment consists of an electrical device connected to the incoming power line to measure incoming power and to produce an impulse to the local plant turbine governors as this power flow changes. In this manner the local turbine governors are made to take practically all of the local plant load change rather than the small part they would take under the influence of normal frequency change on the system. Satisfactory results under this system require that the turbine governors be capable of rapid response, for instance, full travel in about one second of time.

Older turbine governors now in general use may not respond rapidly enough unless extensive modification is made, such as the addition of a modern governor as was mentioned before. Study of this situation has brought about the suggestion that a switch be installed on the conveyor of a rolling mill, so arranged that as the billet approaches the rolls the switch will energize a solenoid which will, in turn, operate on the governor so as to increase steam flow in anticipation of the impending load increase. Momentarily, there would then be a decrease in power over the tie line, with correspondingly less chance of excessive peak demand for purchased power.

In concluding these remarks on the control problem, I would like to leave with you the thought that recent developments have vastly enlarged the possibilities of perfecting the operation of your plants in relation to purchased power and the control of the interchange of power between 25 and 60 cycle generating units within your plant, with or without partial waste heat steam generation. Naturally, boilers must be made equally responsive to rapid fluctuations in demand if extremely rapid turbine governing is to be effective. Combustion control may conceivably be made responsive to change in system frequency, as is the turbine governor. There is no fundamental reason for combustion control not being influenced also by load control equipment. The problem is large, much wider than turbine governor operation alone. It is apparent that each individual case may require separate treatment, but we confidently look forward to a more rational and more satisfactory solution of the power generation problem in your plants for the future.

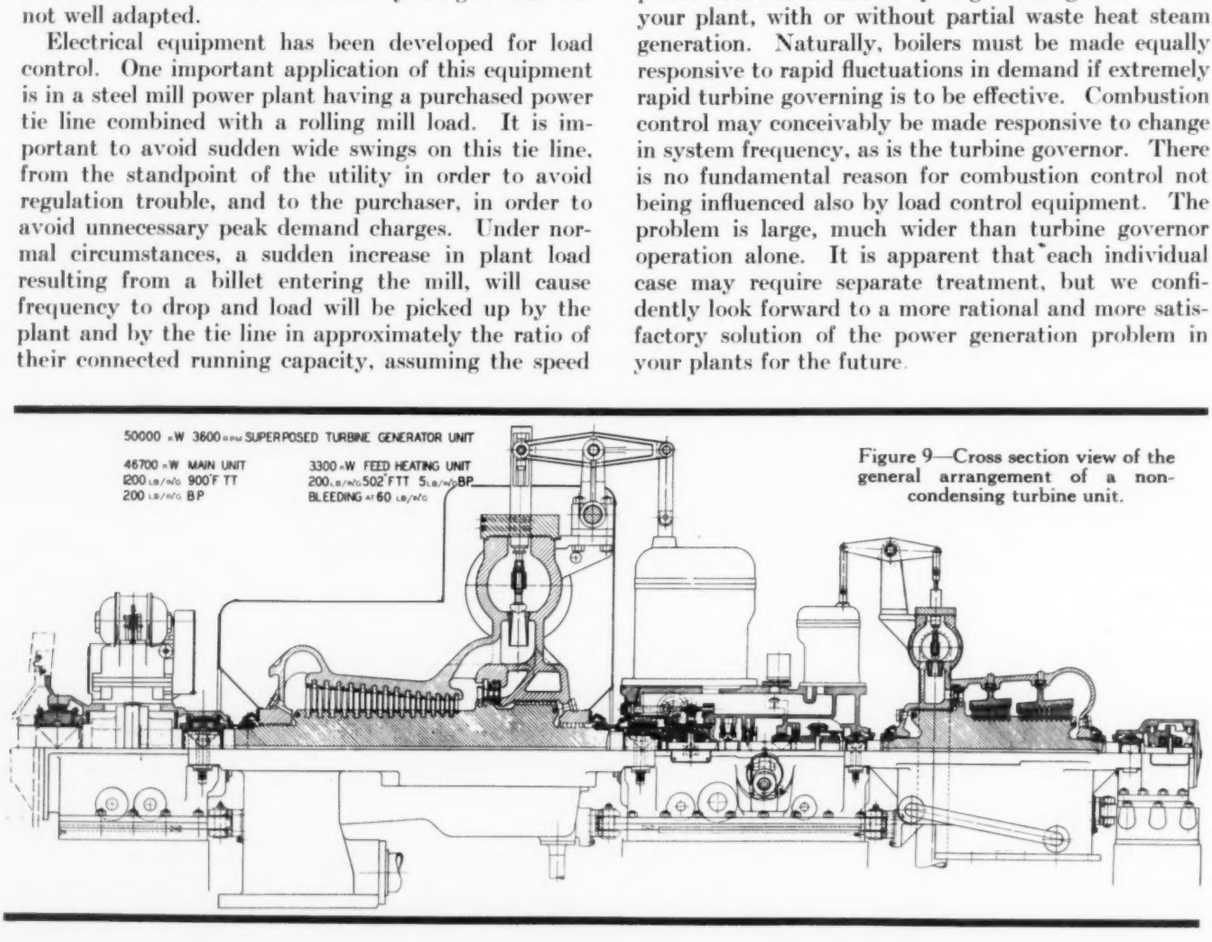

50000 KW 3600 R.P.M. SUPERPOSED TURBINE GENERATOR UNIT
46700 KW MAIN UNIT
200 LB/IN² G 900°F TT
200 LB/IN² G B.P.
3300 KW FEED HEATING UNIT
200 LB/IN² G 502°F TT 5 LB/IN² G B.P.
BLEEDING AT 60 LB/IN² G

Figure 9—Cross section view of the general arrangement of a non-condensing turbine unit.

COMBINATION FIRED BOILERS DESIGN, CONTROL AND OPERATION

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Abstract of paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ THE Ohio Works plant produces pig iron for making open hearth and Bessemer Steel, supplying the bulk of its product as slabs, billets and blooms to the McDonald and Union Works finishing mills for production of strip, hoop and bar products.

Blooming mill drives, Bessemer blowers and part of the furnace blowing equipment are steam engine driven at 150 lbs. pressure; gas engine blowers and generators produce the balance of furnace wind and part of the District electric power requirements. Two turbo-generators supply the balance of the total power to electrified finishing mills and auxiliary drives.

Steam generating equipment before completion of the new plant consisted of fire tube waste-heat boilers producing superheated steam at 150 lbs. pressure; stoker fired, bent tube units producing superheated steam at 250 lbs. for turbo-generators or at 150 lbs. for general mill use, and a multiplicity of scattered inefficient and obsolete blast furnace gas fired units producing 150 lbs. saturated steam for general mill use. These latter units were displaced by the new steam plant.

Replacement of low pressure boilers presented the possibility of attractive economies through installation of higher pressure units and topping turbines. The steam plant was consequently projected as the first step in a program of power and fuel changes as yet incompleted, but originally contemplating installation of back pressure blast furnace turbo-blowers, an extraction turbo-generator and utilization of blast furnace gas in soaking pits. Four steam generators of approximately 1750 B.H.P. were installed for ultimate operation at 475 lbs. pressure with blast furnace gas as the primary fuel and auxiliary powdered coal firing.

Units are four drum, bent tube generators with complete water wall covered combustion chambers, economizers, air heaters, and inter-tube type burners firing through the front water wall tubes. Two unit mill pulverizers were installed for capacity operation of either of two opposite units with space for ultimate installation of additional units, if required. Fans and steam turbine drives are located on the ground floor level with external steel stacks. Settings are completely insulated and steel encased with sectionally supported refractory walls above the water wall areas. Superheaters, drum type steam scrubbers, soot blowers for main tube bank and heat recovery units, overhead coal bunkers and scales, refractory lined concrete hopper bottoms and ash sluicing and transport facilities are part of the auxiliary equipment.

Designed for 475 lbs. 675° F. ultimate operation, these units are being operated initially at 260 lb. pressure. All steam, except that to new boiler auxiliaries, is desuperheated for use in existing prime movers because of steam temperature limitations. A large percentage of the output is reduced in pressure for existing 150 lb. consumers. The pressure reducing and desuperheating facilities are designed for ultimate operation at

C. H. WILLIAMS

design pressure to supplement exhaust and extracted steam and provide adequate flexibility during the transition period. While some capacity limitations and operating difficulties have been encountered because of operation at lower than design pressure these generators have displaced the gas and stoker fired units completely, operating continuously at ratings of 250% on gas only and 450% on dual firing and peaking to 325% and 550% respectively under the same firing conditions.

This plant falls heir to the total fluctuations in gas supply and consumption and to the total steam load

variation of the steel works and electric power loads, including the vicious swings from blooming mill steam drives and steam to turbo-generators supplying the characteristic continuous strip mill power peaks. Some interesting and complicated abnormalities in steam characteristics, feedwater regulation and boiler control develop as a consequence of this load condition and the subnormal initial operating pressure.

Boiler control for this installation comprises complete metering regulation of all functions including automatic cut-in and cut-out of unit pulverizers. The control equipment functions to summarize the total fuel demand, fire blast furnace gas up to the limit of its availability and supply the gas deficiency with coal automatically. Metered air for combustion of one fuel or combination of fuels is supplied and split in the proper proportions for any fuel combinations. Complete flexibility is incorporated for manual manipulation of all functions, load ratio unbalancing, fuel-air ratio control, furnace pressure regulation and shifting of pulverizers between pairs of opposite boilers. Stabilized operation of fans is by means of steam turbine control valves without dampers. Complete safety and load limiting features are incorporated. The control operation has been phenomenal and has proved itself indespensible in handling a nasty fuel supply and load fluctuation condition.

Feedwater makeup of approximately 70% is softened in a hot process plant, deaerated together with condensate return and further conditioned with secondary chemicals ahead of economizers and in the boiler drums. Raw water to the softeners is initially used as a recirculation medium for gas engine cooling coming to softener tanks at around 150° F. Exhaust from boiler and feed pumps auxiliaries supplemented by live steam if required, supplies the remaining feed water heat requirement. Continuous blowdown is flashed to liberate 150 lbs. steam and will ultimately raise the softener makeup water temperature through a blowdown heat exchanger.

WELDING ECONOMICS AND APPLICATION

By E. W. P. SMITH, Consulting Engineer
Lincoln Electric Company
CLEVELAND, OHIO

Paper to be presented before the A. I. & S. E. Annual Convention, Chicago, Ill., Sept. 28, 29, 30, Oct. 1, 1937.

▲ THE prime purpose of the application of welding to the fabrication of any product is to reduce the cost thereof.

Cost, and therefore cost reduction involves really two items. The first of these is what we term the first cost and the second of these is the service life or the performance of the machine or equipment. If, for the same length or duration of time during which satisfactory performance exists, the first cost can be reduced, then there is a cost reduction. Or if satisfactory performance time can be increased for the same first cost, then there is also a cost reduction. In other words, cost reduction is measured in the service life and the cost for that service life, giving a cost for a unit of service life. If the cost of this unit of service is reduced then the entire cost of the product is reduced. It is of course, very evident that the first item, that is the direct reduction of the first cost is the one most usually demonstrated but performance must not be lost sight of.

The performance or service requirements involve the design and the design involves cost. The problem is studied from the viewpoint of cost, service life, design. It is necessary to consider in this service life the kind of load. Load conditions do not in general exist in what might be termed the pure state but in most cases exist in fairly intricate matter and in some cases an exceedingly complicated matter. Before proceeding to the consideration of the complicated problem, it is well to give some thought to the load conditions from the elementary viewpoint and then follow this up with a combination of the various elementary load conditions as they contribute to the service performance and cost reduction.

There is, of course, the pure load condition such as tension, compression, bending. These loads seldom exist in a single state, but are generally combined in some manner usually characteristic of the service to be performed. Tension, compression, bending, etc. are thought of as being the results of load conditions, but no mention is made nor are the rates of application of the load suggested merely by the mentioning of tension compression. There is, of course, the dead load, steady or continued loading, such as the weight of a beam which has been placed in position. Then there is the gradual application of load such as the addition to any piece of equipment of devices or attachments which do not have purely a load carrying function. This may be illustrated by the addition of the floor system to beams. This is very, very gradually applied. The rate of application of the load may be gradually increased until what is termed an "impact" or "shock" load, an exceedingly rapid application of the load is

reached. It is almost self-evident that in the case of the very slowly applied or steady load the conditions are very much different than they are when the load is applied very rapidly. The ability of weld metal and welded joints to meet these conditions as given above is illustrated by the pure tensile specimens, the bending

E. W. P. SMITH

specimens and by the impact specimens. It is to be noted that the impact specimen shows an exceedingly high value. The rate of application is one load condition which must be very thoroughly studied and considered in the application of design to any piece of equipment. There is also the frequency of the application of the load. The frequency of application must not be confused with the rate of application. Impact load is a very high rate of application, but may be applied very infrequently. There is the relatively slow and rather infrequent application of the load such as exists in the case of a stamping press or bending brake.

TABLE 1
Electrode Size

	1/8	5/32	3/16	1/4	5/16	3/8
Labor	57.60	45.40	38.00	20.00	14.00	9.20
Power	6.51	5.91	5.81	5.45	5.28	5.07
Electrode	15.75	14.75	12.75	12.75	12.75	12.75
Interruptions	5.40	3.60	2.40	1.50	.90	.60
O. H.	57.60	45.40	38.00	20.00	14.00	9.20
TOTAL	142.86	115.06	96.96	59.70	46.93	36.82

Labor $0.75 per hour; Power .02 per KWH
50% operating factor; Overhead 100%.

Other type of loads are such that the load is applied a great many times, such as the load existing on a punch press, or reciprocating parts of all kinds. This frequency of application has a most decided bearing upon the characteristics of the design.

The variation of the load must also be taken into account, that is, from tension to compression or from a high tension to a lower tension, or from positive to negative bending or from positive to negative torsion, It has been found that when the load is very rapidly changed and the frequency is very high, or a great number of reversals occur, that the stress distribution becomes a factor which must be carefully studied. There are, therefore, a number of guides in the application of the type of construction used. The tension, the compression, the impact and the fatigue, the rapidly reversing load. The ability of the welded joint to withstand the load, will be illustrated when the paper is presented as well as a fatigue specimen. This has been subjected to a stress of 32,000 pounds per square inch for ten million reversals and then has been bent upon itself 180 degrees.

As mentioned above, all of these load conditions must be studied and the relation of the stress distribution in connection with this load must be given attention so that as uniform a stress as possible will be attained. It is obvious, of course, that if even the smallest section for a very small distance is stressed beyond the

TABLE 2
Cost to deposit 100,000 lbs.

Electrode No.	1	2
Amps.	280	280
Volts	30	30
Rod Efficiency	66.7%	55.8%
Lbs. Deposited per hour	50%	50%
Operating Factor	4.29	3.13
M. G. Set Efficiency	62%	62%
KWH per Pound	1.737	2.38
Hours to Deposit 100,000 lbs.	23310	31949
KWH hours to Deposit	173700	238000
Electrode Required Lbs.	150000	179000
Cost Labor	$16317	$22364
Cost Power	3474	4760
Cost Material	$12750	$15215
	$32541	$42339

tension it will tear or break; that if even in the smallest section subjected to continued reversals, if the stress exceeds 32,000 pounds per square inch it will fail in a relatively short time. Welding fabrication permits uniformity of stress distribution and consequently the utilization of metal to the best possible advantage. This ability to perform and meet the service of load condition of weld metal must, of course, be done at a low cost.

These costs are made up of several different items,—power, the cost of electrode, the cost of labor, and the resultant quality of ability of the joint to meet load conditions. All of these must be taken into account when consideration is given to the item of total costs.

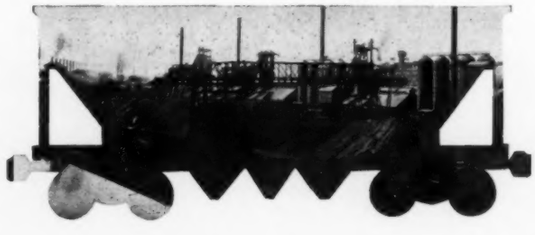
It is obvious, of course, that large generators are more highly efficient than the smaller generators and consequently the larger generator should be used. It is a characteristic of a welding motor generator set that the efficiency curve is relatively flat. In the case of a 300 ampere unit running from 47% at 110 amperes, 25 volts to 59% at 370 amperes, 38 volts, and even at the lower ranges the efficiency is not particularly less than that of smaller machines. Consequently this wide range and high efficiency of the large generator means a lower cost for power.

The cost of electrodes. At the normal rated current it is discovered that it takes from 75 to 90 seconds to consume an electrode. It is evident, therefore, that if larger size electrodes are used that more metal may be deposited. Table No. 1 indicates this with reference to a series of different sizes of electrode, indicating very clearly the higher rate of deposition for the larger electrode and consequently the decidedly lower labor cost. Just the change from 3/16" to 1/4" electrode would involve a cost reduction of 25% to 35%. This is a more or less self-evident statement. However, just because an electrode is consumed in a certain time is no reason to believe that it is the most satisfactory. Table No. 2 indicates a tabulation showing that a variation in performance is of vital importance. To obtain a satisfactory joint, it is necessary that the metal be *deposited in the bead* and join the two parts involved. Therefore, the basis of cost of this *deposited metal* should be considered on the basis of the amount of the metal which is *deposited*, not upon the cost per pound of the electrode *purchased*. Consequently the comparison should be made between given size electrodes for the conditions required, as for example the *deposition* of 100,000 pounds of metal. Note the tremendous difference in cost, due to the difference in performance of the electrodes.

As previously mentioned, service life and dollars and cents cost, must go together to make up the cost item. In the fabrication of parts, is the matter of expansion and contraction, which should be considered. It is found that the use of a few number of beads has a tendency to reduce the distortion as compared to the amount of distortion obtained by using a greater number of smaller beads. This, of course, is an advantage obtained by the use of larger electrodes. It is also found that the use of the larger electrode results in the production of weld metal and deposit of metal of higher ductility than is obtained when a relatively large number of small beads is used. The reason being, of course, the difference in the cooling rate obtained, or to put it another way, if certain speeds of travel and a certain current produces in the metal adjacent to the weld a certain definite change, such as hardness, then if the speed is doubled without changing the current this hardness is increased because in effect it is a small bead, whereas if the current is doubled and the speed is doubled, the hardness is not materially changed. Therefore, it would seem that in the matter of cost that the use of the larger electrode at high speed produces a deposit at a lower cost per pound, and in addition to that the quality is of an exceedingly high order. It is high in ductility, with less distortion, and it is therefore advisable to use the largest size electrode which the design or fabricated part will permit. It is to be very carefully noted that this limitation or qualification is placed upon this statement and in addition to that it is also to be carefully noted that in general the tendency is toward the use of too small electrode, consequently high costs.

Not much has been said directly about the application to steel mill machinery, but a few illustrations will show the applications of this method to steel mill machine. The terrific shock, impact and fatigue load, the high load encountered in steel mill service make it necessary that the weld metal and the joints be able to meet the load conditions satisfactorily and at a low cost. In the outline given of the conditions to be met and the ways they are met will permit the steel engineer to evaluate and consider his load conditions and then use the most effective economic type of welded construction to meet these same load conditions.

I cannot refrain from reminding you in as emphatic a manner as possible that you can build your products of steel better and at less cost and that you gentlemen make the steel. The economic inferences do not, I believe need to be further emphasized.



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SOUTH WORKS ORE BRIDGE COMPLETED

▲ ORE handling bridge No. 4, located on the north vessel dock for blast furnaces five and ten at South Works of the Carnegie-Illinois Steel Corporation has recently been completed. It represents the newest developments in design and construction for this type of structure. Due to local conditions, the bridges on this dock are cantilever structures of rather unusual dimensions.

Bridge No. 4 is a traveling crane 523′–6″ long operating a 20-gross ton (45000 lbs.) ore bucket. The usual capacity of the buckets for this kind of bridge is 10 to 15 tons. The south cantilever is 181 ft. long, the center span 188 ft. and the north cantilever 155 ft. long. The base of rails of trolley is 55 ft. above base of rails of trucks. The trusses are spaced 26 ft. on centers and the base of the towers 32 ft. on centers. The towers of the bridge are mounted on turntables with expansion rollers at one tower and the whole assembly is carried by two trucks spaced 188′–0″ apart, each having 32 spring-supported wheels, and travels on standard gauge tracks. The height from base of rail to top chord of the bridge is 94 ft. The ore-bucket operates at a maximum speed of 175 ft. per minute; the trolley speed is 850 ft. per minute, and the bridge at 75 ft. per minute. The bridge also swings 15 degrees on either side of its normal centerline, making it possible to move the extreme end of one cantilever 134 ft. ahead of the other. The bridge is electrically operated on a 230 volt direct current and controlled by one man located in the trolley cage. The whole structure is propelled by four motors mounted on the trucks, and the power is transmitted to all the wheels through double spur gear reducer units and two lines of floating shafts connected with geared couplings to worm gear speed reducers, which are fastened, in alternate positions, to the wheel axles.

The motors are mounted, one on each end of both trucks. Each motor drives 8 axles and 16 wheels, or one-half the wheels under each truck. Two brakes are used for each unit, one applied on the motor armature shaft and one on the first spur gear shaft. The bridge is equipped with eight spring set safety clamps each gripping the track rails with a force of 100,000 lbs. each. The safety clamps are operated with four separate motors and reduction gears mounted on the top of the trucks. To guard against over-skewing, the bridge is provided with two automatic limit switches, one set for 13 degrees and one for 15 degrees on either side of the normal position of the bridge. It is also provided with anemometers which shut off the current when the wind velocity exceeds 25 miles per hour.

The trolley, cage and bucket is a

General view of ore bridge at South Works of Carnegie-Illinois Steel Corporation, looking East

North cantilever arm of new ore bridge. The one bucket, in center, has a 20 gross tons capacity.

unit traveling the full length of the bridge, and loaded with ore this unit weighs about 330,000 lbs. It is carried by ten spring-supported wheels and operated by four motors, two for the bucket and two for the trolley. The trolley is provided with magnetic rail sanders, automatic slowdown and stopping controls. The ends of the bridge are also equipped with draft gear spring trolley bumpers compressing about 21 lbs. before closing, and capable of withstanding the impact, due to full load and speed of the trolley.

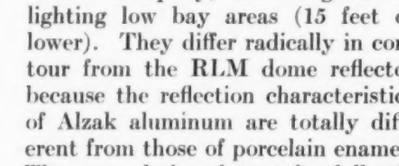
The general design of this bridge was under the direction of Mr. J. F. Brown, Chief Engineer South Works and Mr. W. S. Hall, Chief Engineer of the Carnegie-Illinois Steel Corporation, Chicago District. The structural steel was fabricated and erected by the American Bridge Company.

REFLECTORS FOR LOW BAY LIGHTING

▲ THE new Ivanhoe Reflectors, as illustrated and manufactured by the Miller Company, are designed for lighting low bay areas (15 feet or lower). They differ radically in contour from the RLM dome reflector because the reflection characteristics of Alzak aluminum are totally different from those of porcelain enamel. They are designed to take full advantage of the high reflection efficiency and more accurate control of reflected light that is possible with Alzak aluminum.

Unusually widespread distribution of light is a major feature of these new reflectors whose angle of cut-off is in accordance with latest improved illumination standards. This broad distribution of light is significant because it provides uniformity of illumination from exceptionally wide spacing of outlets.

Reflector designed for lighting low-bay areas fifteen feet or lower.



DROP FRAME RAM TRUCK

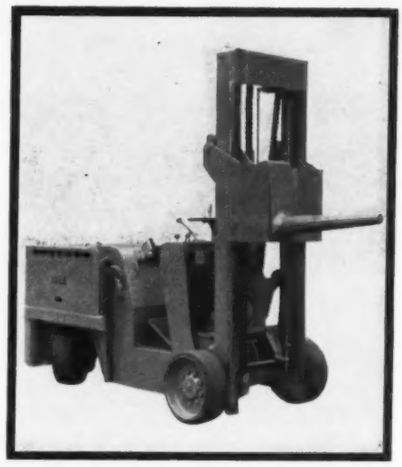
▲ THE Yale & Towne Mfg. Company, Philadelphia, Pa., announce a new design drop-frame ram truck. This machine has been designed to incorporate the operating and mechanical advantages desirable in this class of equipment, and will be furnished in capacities from 4000 to 16,000 lbs., with end or center control.

Drive wheels are of the non-steer type and are on the load end of the truck. The steering trailer wheels are under the battery, and are designed to give a very steep angle of steer to reduce turning radius to a practical minimum consistent with capacity.

With this construction there is a rigid, non-steer drive axle, with widely-spaced bearings in each of the wheels, and take the heavy load directly through the axle rather than through steering knuckles. This feature is very important from a maintenance standpoint, as well as for easy steering. On a machine of 8000 lbs. capacity, there is a load of approximately 14,000 lbs. on these wheels when carrying the full load. A load of these proportions requires steering knuckles and thrust bearings larger than can be put in a 22″ diameter wheel, hence the importance in the adoption of non-steer wheels under the load.

In normal ram truck service, the load will project approximately as far beyond the drive or load wheels as does the front or battery end of the truck. In other words, the pivot or focal point of steer will be approximately in the center of the "truck plus the extended load." With a two wheel steer, this means that we have a minimum steering radius, and are able to turn in minimum aisles.

Where four wheel steer is used, i.e., load wheels of the steer type, the extended ram with its load swings out on a wide circle, and with a ram or load approximately five feet long, a four wheel steer truck has a longer turning radius on account of the sweep of the load, than our design which has a two wheel steer. In other words, there is not only maintenance advantage, but in addition, a shorter turning radius in a narrow aisle condition. It must be pointed out, however, that when the ram is only 24–30″ long this condition may not apply.



Drop-frame ram truck built in capacities from 4000 to 16000 pounds, with end or center control.

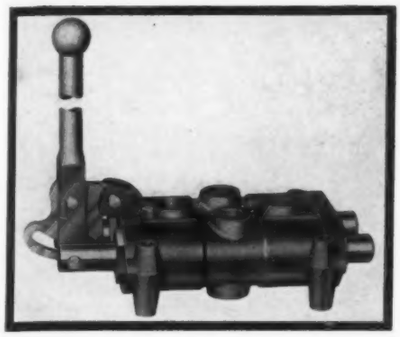
The non-steering drive wheel under the load permit making the truck of minimum overall width at the load end which in many jobs is a valuable feature as it permits depositing a load close to a wall.

In this design there is incorporated a feature which has proven exceedingly valuable on other trucks that have now been in service for a year and a half and has proved its merits from the standpoint of safety as well as operation. This feature is an articulating frame which was first introduced on retracting tilting fork machine, a number of which are now in use.

BRONZE FORGED HOUSING VALVE

▲ THE design of a new valve manufactured by C. B. Hunt and Son's Company of Salem, Ohio, embodies the same no metal-to-metal wear principle and minimum of moving parts as characterizes this company's already well known line of "quick-as-wink" air control valves.

Illustration shows bronze forged housing valve hand lever operated, for 4-way operation. Also built for



Bronze forged housing valve, hand lever operated for four-way operation.

2-way and 3-way. Made in ½" ¾" and 1" sizes, in two styles, for 1000 pounds working pressure and for 2000 pounds working pressure. The bronze forgings used as housings are among the largest bronze forgings ever made.

The employment of the dropped forged bronze housing with its high physical strength affords an additional factor for long life with water or corrosive fluids.

In the "quick-as-wink" valving principle, the valving operation is accomplished in the 2-way valves by only one moving part; in the 3-way and 4-way valves by coincident motion of two valve bodies or plungers. The valve bodies or plungers are made of stainless steel. These are "free-floating" in special packings, avoiding metal-to-metal contact. Balanced port action in conjunction with the valving ring and the no metal-to-metal contact, is claimed to provide a combination for extremely long life and satisfactory performance in hard service. Short travel is an aid to easy operation. Accessibility is such that complete inspection, replacements of parts and re-assembly can be made in a few minutes and without disturbing the hydraulic piping. Connections are provided so that piping may be permanently connected above or below housing. The only internal moving parts, the stainless steel valve bodies or plungers in several years of hard continuous service have shown imperceptible wear due to valving action, in millions of operations.

Complete new catalog "quick-as-wink" air and hydraulic control valves is now on the press and will soon be available. In compiling the new catalog, special effort has been made to include all possible engineering data.

▲ SALEM Engineering Company has established main offices in Salem, Ohio, in a newly purchased building, located at 714 South Broadway. The building has been reconditioned and will be occupied by the engineering staff, from which office the activities of the foreign offices in London, England, and Welland, Ontario, and domestic offices located in New York and Pittsburgh, will be directed.

The Company with its new and larger plant is now in position to serve industry in a more efficient manner.

ELECTRIC FURNACE FOR ALLEGHENY

▲ Allegheny Steel Co., has just put into production at its Brackenridge, Pa., plant a new 25 ton electric furnace, adding 36,000 tons annually to its production capacity on high alloy stainless and corrosion-resisting steels.

The company has added 156,000 a year to its steel-making capacity in the last eighteen months. Besides installing two electric furnaces in that period, it also put into operation two dismantled open-hearth furnaces which had never been used since their acquisition with other properties in 1929.

This additional capacity was needed to furnish steel for recent increases in Allegheny's finishing capacity, particularly at the West Leechburg plant acquired last year, where the recent installation of additional rolling equipment, annealing and normalizing furnaces, picklers and auxiliary equipment effected a 50 percent increase in alloy steel strip finishing capacity.

The company has expended approximately $7,000,000 for improvements and extensions since 1929, when the West Penn Steel properties were acquired. The entire expenditure was financed from earnings.

Allegheny Steel Co. now has furnace capacity for producing 500,000 tons of raw steel a year, with modern and efficient mills for producing from this output of stainless high alloy, special analysis electrical and magnetic, and carbon steels a wide variety of wide and narrow sheets, strips, plates, bars and other hot and cold rolled products; drawn and welded tubing, castings, and stampings. Recently developed water terminals provide both plants with facilities for economical transportation of raw materials, and shipment of finished products to river points.

The company's volume of business and profits for the first half of 1937 were the largest in its history since 1929. Unfilled orders on hand insure full operation at both Brackenridge and West Leechburg for several months more at least.

25-Ton electric furnace recently installed at the Allegheny Steel Company, Brackenridge plant. It will add 36000 tons to the annual plant capacity.

Directors, supervisors, camera men and electricians focus their attention on an open hearth furnace worker as he poses for a closeup at Gary Works of the Carnegie-Illinois Steel Corp. during the filming of the U. S. Steel Corporation's new technicolor film.

U. S. STEEL FILMS INDUSTRIAL MOVIE

▲ HAVING completed a two-week long, high-speed production schedule at Gary Works of the Carnegie-Illinois Steel Corporation, the film crew shooting America's first technicolor short industrial feature film moved on to South Chicago to photograph the electric furnaces and beam mill at South works. The troupe of 21 Hollywood camera men, technicolor experts, electricians and other technicians are making the picture for the United States Steel Corporation. Twenty steel plants will figure in the completed film, which is being produced by Hollywood Director Roland Reed.

Following a schedule of several days at South works, the photographers will go to Joilet to cover the new rod mill of the American Steel and Wire Company and will complete their Chicago schedule at the American Steel and Wire plant at Waukegan.

The film company has been on location since August 14, beginning at the Iron Range at Hibbing, Minnesota. At Hibbing, miners of the Oliver Iron Mining Company were filmed as they unearthed the raw ore. The giant ore boats of the Pittsburgh Steamship Company fleet were photographed as they were loaded with ore at Duluth, and as they unloaded the ore at the harbor of Gary works.

Actors in this picturization of the romance of steel are all employees of United States Steel Corporation subsidiaries. No professional actors are used and each man is shown doing his everyday work. Three versions of the picture are being produced. Two of these are in technicolor and sound and will be distributed to theaters, clubs, engineering societies and other groups. The third film is a long black and white version for educational uses.

When the filming at Chicago district plants of United States Steel Corporation subsidiaries is completed, the movie troupe will leave for Cleveland and Pittsburgh where the actual filming of scenes will be completed.

ONE TON WELDING MANIPULATOR

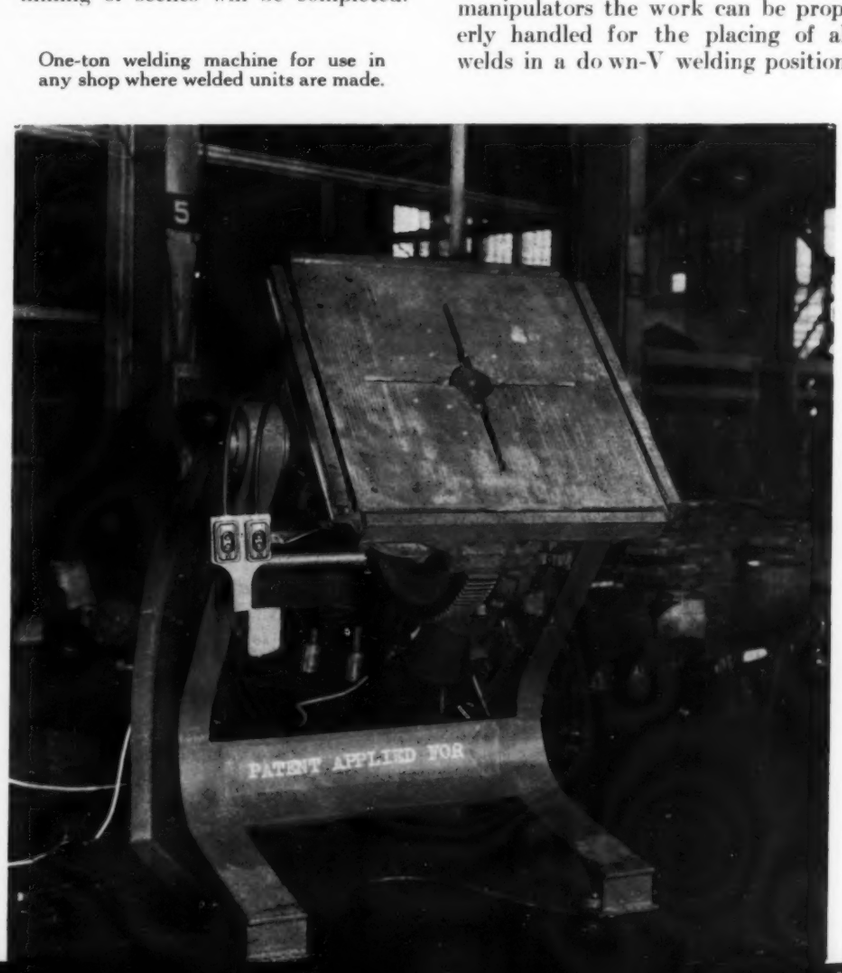
▲ SHOWN below is a one-ton Welding Manipulator, for use in any shop where welded units are made, of an entirely new design which affords many advantages in handling the job so that all welds can be made in the down-V welding position.

The faceplate can be tilted from a position of 45° back underneath the vertical around through the vertical to a position of 30° beyond the horizontal, making a total tilting angle of 165°. In addition to the tilting angle, the faceplate may be rotated through 360° in either direction simultaneously with or independent of the tilting.

Both motions are individually power driven by separate motors and controls through self-locking worm units which permit locating the faceplate in an infinite number of positions without the use of locking pins, clutches, etc.

The faceplate has many provisions for easily and readily mounting the work consisting the tee-slots, through holes, tapped holes and means for supporting extension bars. With our manipulators the work can be properly handled for the placing of all welds in a do wn-V welding position.

One-ton welding machine for use in any shop where welded units are made.



ITEMS OF INTEREST

Frank F. Slick, general superintendent of the Edgar Thomson Works of the Carnegie-Illinois Steel Corporation, Braddock, Pennsylvania, has been granted an extended leave of absence due to failing health.

Mr. Slick's condition became increasingly serious earlier in the year, necessitating at that time a lengthy rest in a hospital. After returning to his home, Mr. Slick found the many duties of his office too heavy for his condition and took a month's vacation at his summer cottage on French River in Canada. He returned to his desk, but was forced by continued ill health to decide upon the thorough rest a leave of absence would permit.

His departure will break a continuous career of 42 years with the company, all of which time was spent at Edgar Thomson Works, except for a four-year period from 1902 to 1906, when he was assistant engineer of ordinance in the city office at Pittsburgh.

He started as a clerk in the engineering department and became in turn a tracer, draftsman and roll designer. He was made superintendent of the No. 3 rail mill upon his return from the Pittsburgh offices in 1906 and held that position until late in 1922, when he became operating superintendent.

He served as assistant general superintendent from August 1, 1925, until April 30, 1933, when he was appointed acting general superintendent. He was given the position of general superintendent five months later and has held that post until the present time.

▲

Harry L. Brindle, assistant general superintendent of the Youngstown area of the Carnegie-Illinois Steel Corporation, has been appointed acting general superintendent of the Edgar Thomson Works, Carnegie-Illinois Steel Corporation, Braddock, Penna.

Mr. Brindle succeeds Frank F. Slick, who was granted an indefinite leave of absence effective September 1, due to a lengthy illness.

Mr. Brindle is completing 32 years of continuous service with the company in which he rose from roll turner at the New Castle Steel Works to his present position. He was employed in the roll shop, as a machinist and as assistant machine shop foreman at the New Castle Works during the 14 years from 1905 to 1919.

On April 1, 1919, he was transferred to the Farrell Steel Works as assistant master mechanic and became in turn master mechanic, assistant general superintendent and general superintendent. Shortly after the consolidation of several United States Steel Corporation Subsidiaries into the Carnegie-Illinois Steel Corporation, Mr. Brindle was appointed assistant general superintendent of the company's large operations in the Youngstown area and held that position until his current appointment.

▲

Fred B. Loveland, who has been superintendent of the rolling mills of Ohio Works at Youngstown since 1933, succeeded Harry L. Brindle recently appointed acting general superintendent of Edgar Thomson Works, Carnegie-Illinois Steel Corporation, Braddock, Pennsylvania. Mr. Loveland began his career with United States Steel Subsidiaries in 1906, as a clerk in the Greenville, Pennsylvania plant of the National Tube Company. His other positions have been, bill clerk, Carnegie Steel Company, Greenville; assistant order clerk, Ohio Works, Youngstown; order clerk, Ohio Works; assistant superintendent and superintendent of the rolling mills at Ohio Works.

▲

Frank P. May has been appointed assistant chief engineer of the Clairton Works, Carnegie-Illinois Steel Corporation. Mr. May was graduated from the School of Electrical Engineering at Purdue University in 1913. His first position following graduation was assistant to the chief engineer at Mingo Works of Carnegie Steel Company. In 1916 he was advanced to assistant superintendent of the electrical depart-

FRANK F. SLICK

HARRY L. BRINDLE

FRANK P. MAY

ment, and in 1927 was named assistant superintendent of maintenance. In 1933 he was named assistant superintendent of maintenance in charge of the electrical department from which position he goes to Clairton.

▲

H. L. Coe has been appointed assistant superintendent of maintenance at Mingo Junction Works of Carnegie-Illinois Steel Corporation to replace Frank P. May.

▲

Alfred C. Goins has been appointed assistant superintendent of cold reduction at the Sheet mill, Gary Sheet and Tin Division, Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. Goins succeeds Arno L. Billeter who has been transferred to the new Irvin Works of Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania. Mr. Goins has been employed in the Gary Sheet and Tin Mills since 1929 when he began as a tin mill electrician. He has served as turn foreman and temper rolling foreman in the sheet mills.

▲

Peter J. Nebe was appointed annealing superintendent of the tin mill, Gary Sheet and Tin Division, Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. Nebe succeeds J. B. Richards as superintendent of annealing at the tin mill. He has been with Carnegie-Illinois since 1916, having previously worked for several other companies in the steel industry for a number of years.

▲

John E. Soyring has recently been appointed night superintendent of annealing at the tin mills, Gary Sheet and Tin Division, Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. Soyring succeeds Peter J. Nebe, who was appointed annealing superintendent at the same mill. He has been with the company since 1928, when he started in the Shenango Works at New Castle, Pennsylvania. He went with the Gary Sheet and Tin Division in 1933.

George P. Burks was recently appointed as chief chemist in connection with blast furnaces, open-hearth and rolling mills at Gary Works of the Carnegie-Illinois Steel Corporation. Mr. Burks, a graduate of Wabash College with a B. A. degree in chemistry and biology, has been connected with Carnegie-Illinois, largest United States Steel Corporation subsidiary, since 1921. He has served at Gary in various capacities and has been assistant chief chemist since 1922.

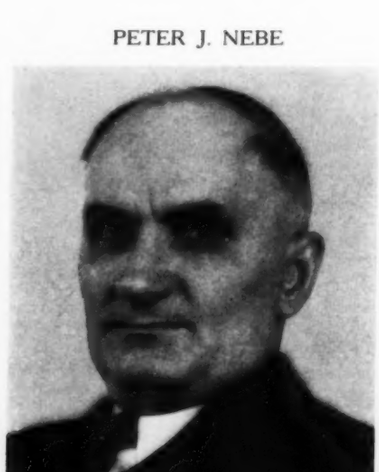
GEORGE P. BURKS

▲

Arno L. Billeter, formerly assistant superintendent of cold reduction at the sheet mill, Gary Sheet and Tin Division, Carnegie-Illinois Steel Corporation, Gary, Indiana, was transferred to the new Irvin Works of Carnegie-Illinois at Pittsburgh, where he will have charge of the cold reduction department, Mr. Billeter has been at the Gary Sheet and Tin Mills since 1919.

ALFRED C. GOINS

PETER J. NEBE



ARNO L. BILLETER

Arthur H. Young, vice-president in charge of industrial relations, United States Steel Corporation, New York, has retired, effective October 1. Mr. Young was one of the pioneers in the field of industrial relations, where he has been active for thirty years. After graduation from the Joilet Township High School in 1901, he became identified with the Illinois Steel Company, where he worked as roll hand, leverman and timekeeper at the Joilet and South Chicago plants. He later went with the Colorado Fuel and Iron Company and remained until 1912, when he returned to the Illinois Steel Company as supervisor of labor and safety. During the following twelve years he engaged in safety and industrial relations work with the American Museum of Safety, with the Government as chief safety expert with the U. S. Arsenals and Navy Yards, and with the U. S. Employees Compensation Commission and as manager of industrial relations for the International Harvester Company. In 1924 he became industrial relations counsel to Industrial Relations Counselors, Inc., from which he resigned in 1934 to become vice-president in charge of Industrial relations with the United States Steel Corporation.

ARTHUR H. YOUNG

▲

Sam Davey, superintendent of the tin plate division at Canton, O., of the Republic Steel Corp., Cleveland, and brother of W. H. Davey, president of the W. H. Davey Steel Co., Cleveland, has resigned to become vice president in charge of operations of the Canton Metal Decorating Co., Canton, O. Mr. Davey was one of the founders of the Canton Tin Plate Co. in 1930 and has held his present position since the company became part of the Republic Steel Corp.

▲

C. W. Phillips, general master mechanic of the Warren and Niles district of Republic Steel Corp., Cleveland, for a number of years, will become general master mechanic of the Corrigan-McKinney district in Cleveland, which includes the new continuous strip mill nearing completion. Mr. Phillips will be succeeded by C. S. McKinney, who has been one of his assistants for several years.

▲

Frederick R. Ward has been made assistant district manager of the Chicago district of the Republic Steel Corporation. Mr. Ward's first position was as a chemist for the Corrigan-McKinney Steel Company, Cleveland, and he left there to become chief chemist for the American Manganese Company. In 1919, he became superintendent and meterologist for the Tennessee Manganese Company. From there he became superintendent of operations for the Graham Furnace Corporation, in 1922, and in 1923 he went with the Jones & Laughlin Steel Corporation, as superintendent of the bar mills at the Pittsburgh Works.

Mr. Ward went to the Chicago district of Republic Steel Corporation on July 13, 1936, as assistant superintendent of the finishing mills and special process division, which position he held until his present appointment.

▲

Died

John Biggert, service engineer for nineteen years of United Engineering and Foundry Company, in his home at Pittsburgh on August 10.

Mr. Biggert was educated at Pittsburgh Academy and at Western University of Pennsylvania (now University of Pittsburgh), graduating as an engineer in the class of 1906. He was connected in a mechanical capacity with Carnegie Steel Company, and later with Jones & Laughlin Steel Corporation before going with United Engineering and Foundry in 1908.

JOHN BIGGERT

Mr. Biggert collaborated in development of rolls for the terrific stresses of 4-high mill duty, in introduction of anti-friction bearings in the rolling mill field, in faster rolling speeds and heavier reduction, in many of the problems of rolling stainless steel, in matters of lubrication and cooling, in the proper use of new reels and other accessories, in the diagnosis and correction of mill misbehaviour, and in devising mill practices which are now standard.

J. "JAKE" M. FARIS LEAVES YOUNGSTOWN SHEET AND TUBE AFTER 44 YEARS SERVICE

By ERNEST N. NEMENYI †

REPRINTED FROM THE YOUNGSTOWN VINDICATOR, JULY 1, 1937

After 44 years in the steel industry where he started as a mechanic, J."Jake" M. Faris, announced his retirement July 1 from active service with Youngstown Sheet & Tube Co., which he helped to build.

Nobody, except some of his most intimate friends, call Faris by any other name than "Jake". His intimate friends call him "Jakie".

It was 44 years ago when Jake as a young mechanic who learned his trade in his native Pomeroy, down on the Ohio River, below Marietta, had a "job" to do in the plant of the Pomeroy Rolling Mill Co.

J. "JAKE" M. FARIS

A man watched the young mechanic, who began his apprenticeship at the age of 15, do a good job.

Was Offered New Job

"Young fellow, do you want a job with me–" the watcher asked. He was James A. Campbell, superintendent of the plant.

"Sure", said Jake, and ever since that time until the death of Mr. Campbell, he had been with him.

Campbell came to Youngstown as superintendent of the old Valley mill in 1896. Jake Faris came with him as master mechanic. He left for a day—it was July 1, 1896—to go back to Pomeroy and marry his wife, Carrie E. Genheimer, who yesterday "kicked" because Jake told his life's story.

Came Here Next Day

July 2, 1896, Jake and his bride of a day came to Youngstown and have lived here ever since.

Youngstown Sheet & Tube Co. was organized in the late fall of 1900. Early in 1901 Jake was drilling a hole and installing a pump on the bank of the Mahoning to furnish water for the concrete foundations of the first puddle furnaces Jim Campbell was building. The pipe from the river to the site went through a wheat field.

As superintendent of machinery and the electrical department Faris was at the elbow of Jim Campbell as unit after unit of the new great and most self-contained plant of the steel industry was built.

Was Aid to Reilly

Faris was made assistant to Vice President W. C. Reilly in June 1928 and he stayed with Reilly until that gentleman retired two years ago, when Faris was made special consulting engineer.

Now after 36 years of continuous service with Sheet & Tube Faris gives up active work, but he will continue to be of value to the company as a consultant, just as Mr. Reilly, who often visits the Sheet & Tube offices.

Reilly and Faris are the only two men left who started with Mr. Campbell on the production end of Sheet & Tube and saw it grow from a struggling puddle mill to the giant property it now is.

"After long and faithful service Mr. Faris retired from active work on July 1." Frank Purnell, president of the company, who started as an office boy while Faris was building mills said today. "The company, however, will not lose Mr. Faris' valuable and long experience. He will be called upon in a consulting capacity. There are few with a more thorough knowledge of the company's properties than Mr. Faris."

†FINANCIAL EDITOR—"YOUNGSTOWN VINDICATOR"

"YOU COVER A WIDER RANGE AND WELD 15% TO 20% FASTER WITH THE NEW 'SHIELD-ARC SAE'—

"Set for welding thin sheets, this new Lincoln gives Slim the skill and fine touch of a modiste. And set wide open, the 'SAE' is a power house on wheels. With it, I can pour out the molten metal like a steel furnace.

"They tell me that the wider range and greater speed of this new welder are made possible by a combination of plus features. Make a note of these:

★ **"A SELF-PROTECTING MOTOR** enables you to use larger electrodes and weld at heavier loads continuously without danger of burnout.

★ **"INDEPENDENT EXCITATION** steadies the arc at all times. It's especially valuable at the low current values such as Slim needs.

★ **"DUAL *CONTINUOUS* CONTROL** gives you a wider selection of both voltage and current values and 'top' performances at every setting.

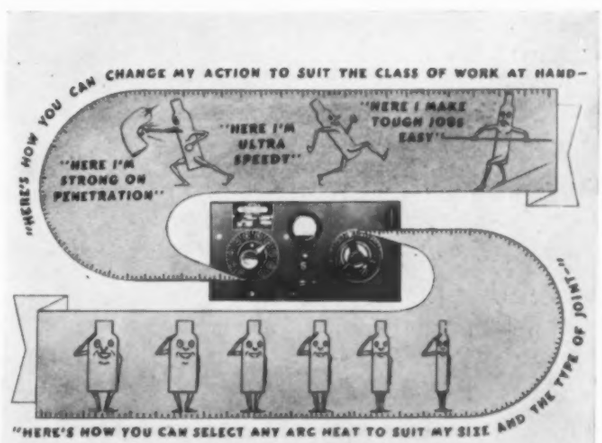
"In effect, you get two or three welders of different sizes when you buy one of the 'Shield-Arc SAE' machines. Yours for lower welding costs,

"FLEETWELD ROD"

—Spokesman for all progress-minded welding electrodes and emissary of

THE LINCOLN ELECTRIC COMPANY

Largest Manufacturers of Arc Welding Equipment in the World.


"HERE'S HOW YOU CAN CHANGE MY ACTION TO SUIT THE CLASS OF WORK AT HAND—
"HERE I'M STRONG ON PENETRATION"
"HERE I'M ULTRA SPEEDY"
"HERE I MAKE TOUGH JOBS EASY"
"HERE'S HOW YOU CAN SELECT ANY ARC HEAT TO SUIT MY SIZE AND THE TYPE OF JOINT"

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THE LINCOLN ELECTRIC COMPANY
Dept. Z-424 Cleveland, Ohio

My welding application is_____
How can the "SAE" do it faster?

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Name _____ Position _____
Company _____
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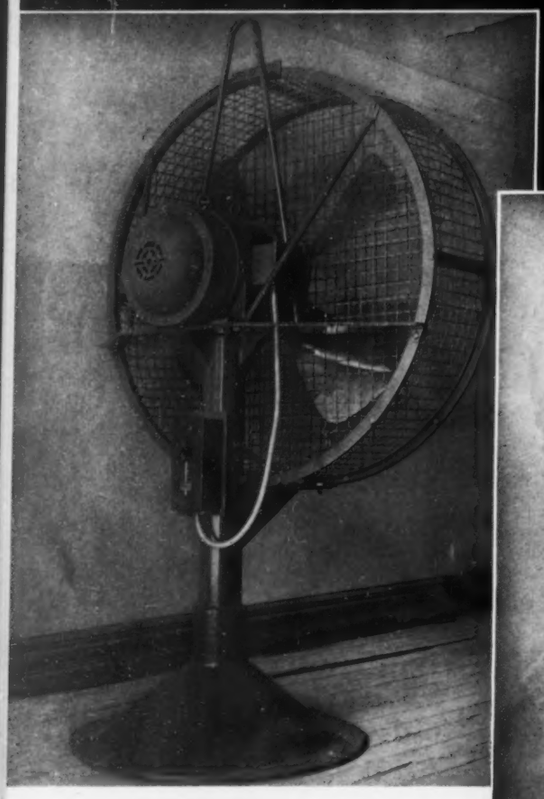
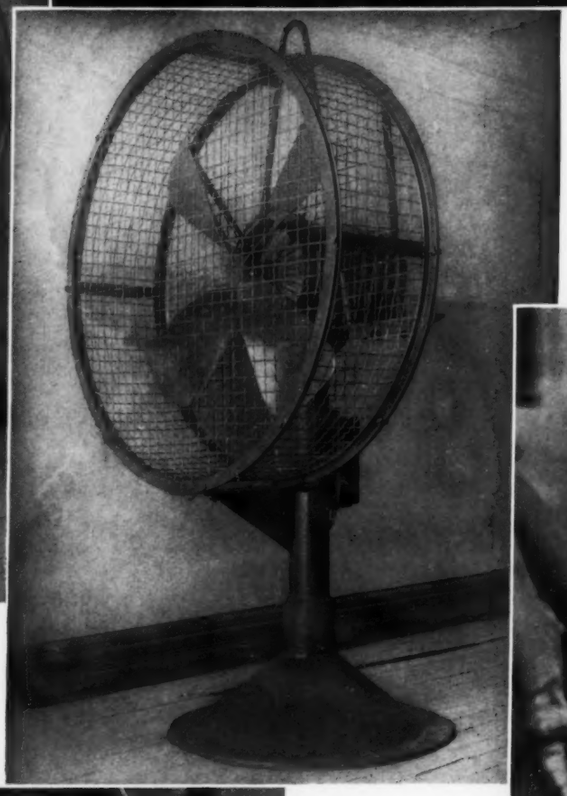
EVERY STEEL MILL REQUIREMENT





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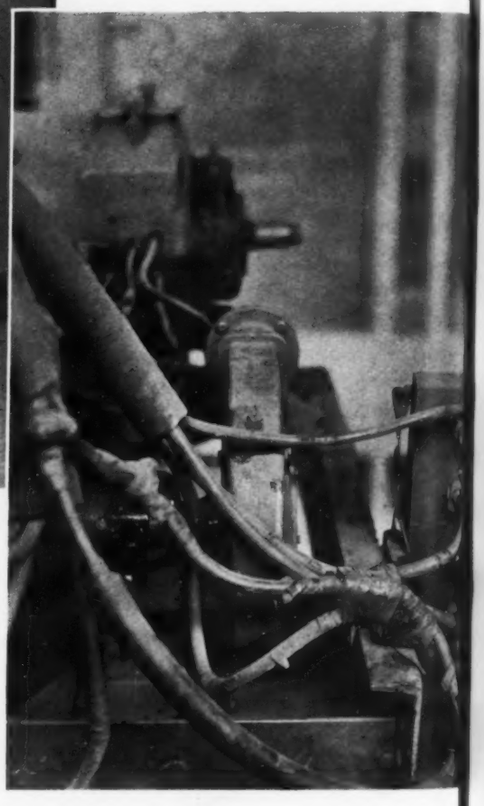
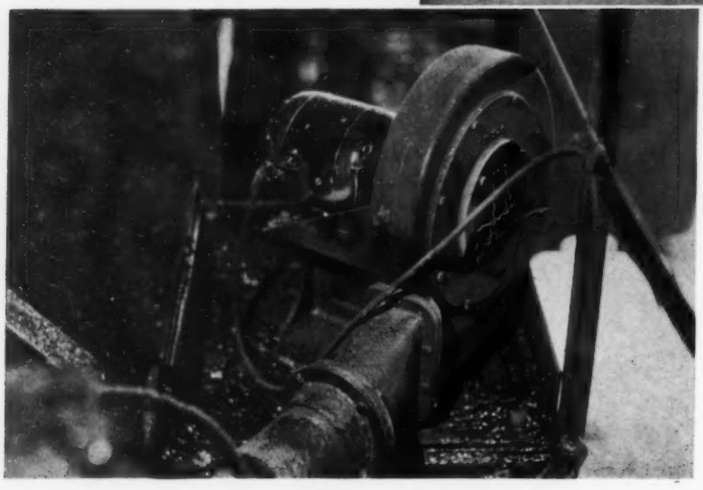


Truflo Blower installed on crane in open he



Truflo Blower installed on charging machine.

Truflo equipment can be built to your own specifications. For additional information and descriptive data write **The Truflo Fan Company, Harmony, Penna.**

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HARMONY **PENNA.**

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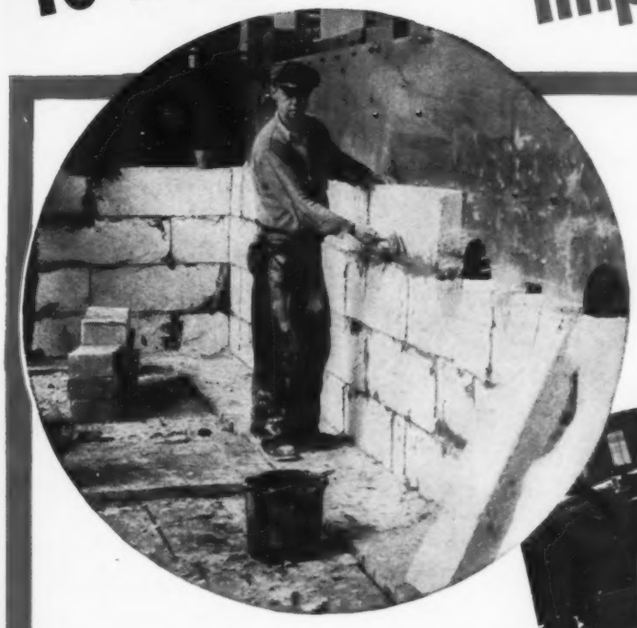

J-M SUPEREX BLOCKS, shown above on a soaking-pit installation, are recognized as the outstanding block insulation behind refractory linings in service up to 1900° F. Unequaled in insulating efficiency, they actually cost less to install.

(Below) BOTH SIL-O-CEL C-22 and JM-20 BRICK are equally effective as back-up insulations and as insulating refractories for temperatures up to 2000° F. This normalizing furnace is constructed entirely of Sil-O-Cel C-22 Brick, a construction which makes possible thinner furnace walls and increased operating efficiency.

Johns-Manville Insulating Materials are designed to solve every steel-mill insulation problem

FOR three-quarters of a century, the steel industry has looked to Johns-Manville for the efficient and economical solution of every heat-insulation problem.

Today, J-M Insulating Materials are giving exceptional service in the world's largest steel mills . . . holding temperatures within the most effective ranges with the minimum amount of fuel . . . guarding against costly heat waste from every type of furnace.

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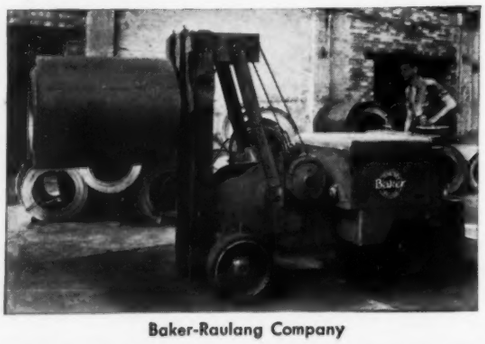
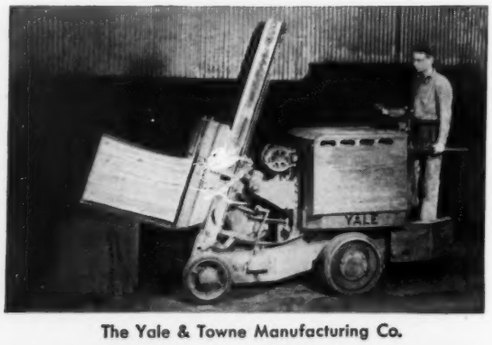


Baker-Raulang Company



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Exide-Ironclad Batteries have enormous power ability. They can deliver an increasing power output up to 20 times the normal rate! And maintain a high average voltage even at high rates of discharge. Exide-Ironclads can *give* it . . . and Exide-Ironclads can *take* it. They last for years . . . and require a minimum of attention.

Engineers and Maintenance Men everywhere agree that for efficient steel mill material handling service, Exide-Ironclads are the answer.

THE ELECTRIC STORAGE BATTERY CO., Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
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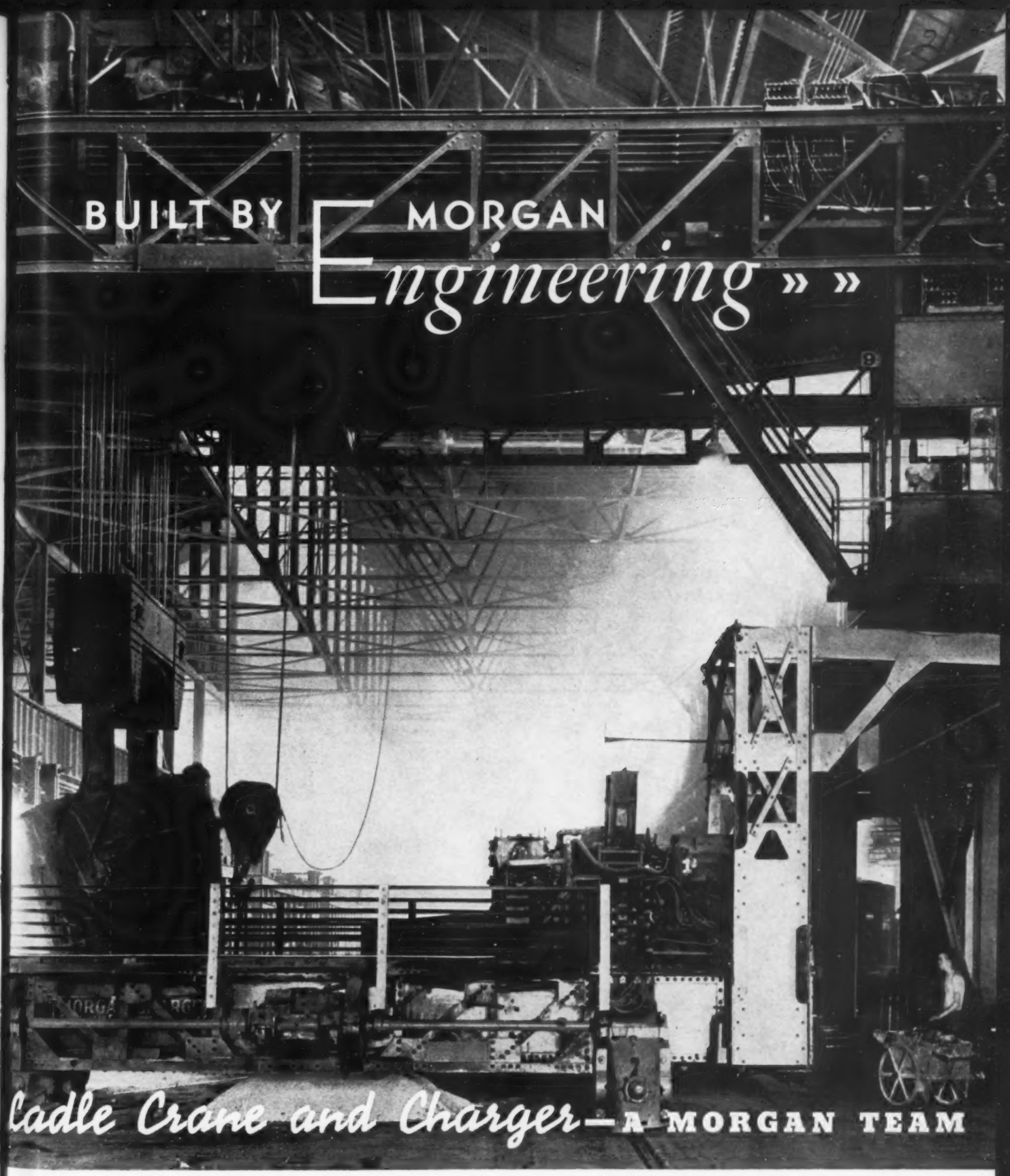

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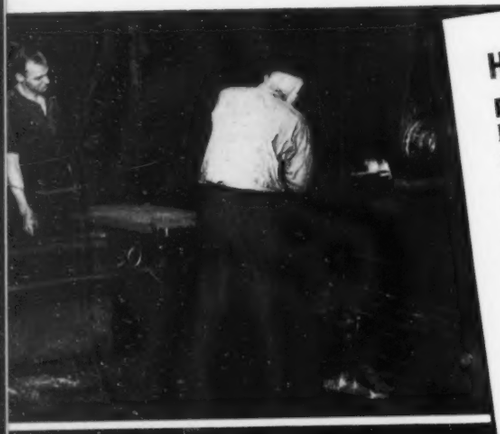

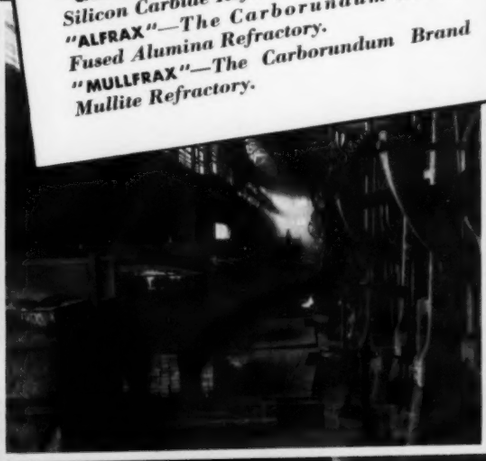

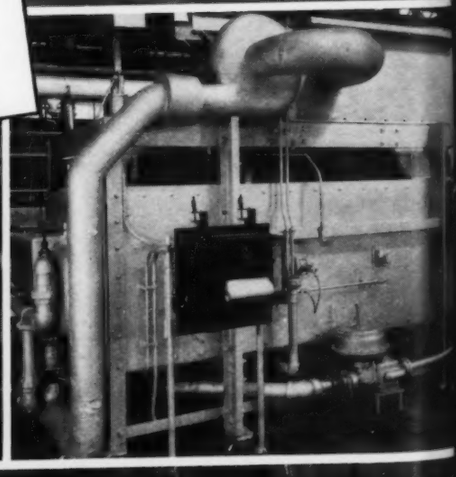

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Refractories by Carborundum have become the standard Super Refractories of the metal industry because:

1. *They are not affected by high temperatures.*
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The many applications of Carborundum Brand super refractories in the metal industry are too numerous for complete listing. "Carbofrax", "Alfrax", or "Mullfrax" refractories, however, are used as muffles, hearths, supports or complete linings in stainless steel annealing furnaces—tungsten carbide sintering furnaces—controlled atmosphere furnaces for alloy steels—forging, drawing, tempering, hardening and carburizing furnaces—ferrous and non-ferrous melting furnaces.

In hundreds of installations, these refractories by Carborundum are speeding up production—bettering the quality of the product—reducing costs.

We would be glad to discuss your problems at any time.

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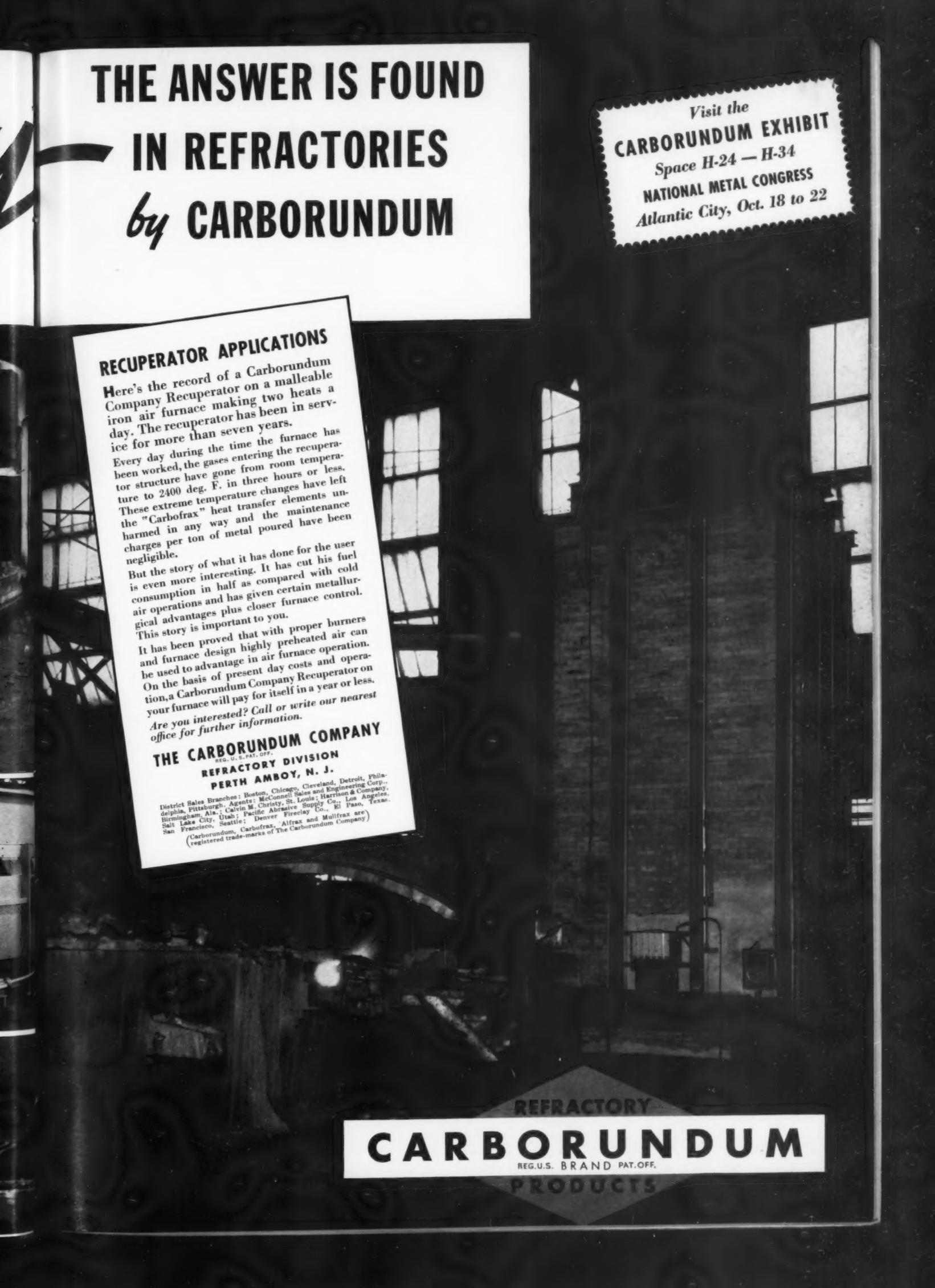
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Here's the record of a Carborundum Company Recuperator on a malleable iron air furnace making two heats a day. The recuperator has been in service for more than seven years.
Every day during the time the furnace has been worked, the gases entering the recuperator structure have gone from room temperature to 2400 deg. F. in three hours or less. These extreme temperature changes have left the "Carbofrax" heat transfer elements unharmed in any way and the maintenance charges per ton of metal poured have been negligible.
But the story of what it has done for the user is even more interesting. It has cut his fuel consumption in half as compared with cold air operations and has given certain metallurgical advantages plus closer furnace control. This story is important to you.
It has been proved that with proper burners and furnace design highly preheated air can be used to advantage in air furnace operation. On the basis of present day costs and operation, a Carborundum Company Recuperator on your furnace will pay for itself in a year or less.
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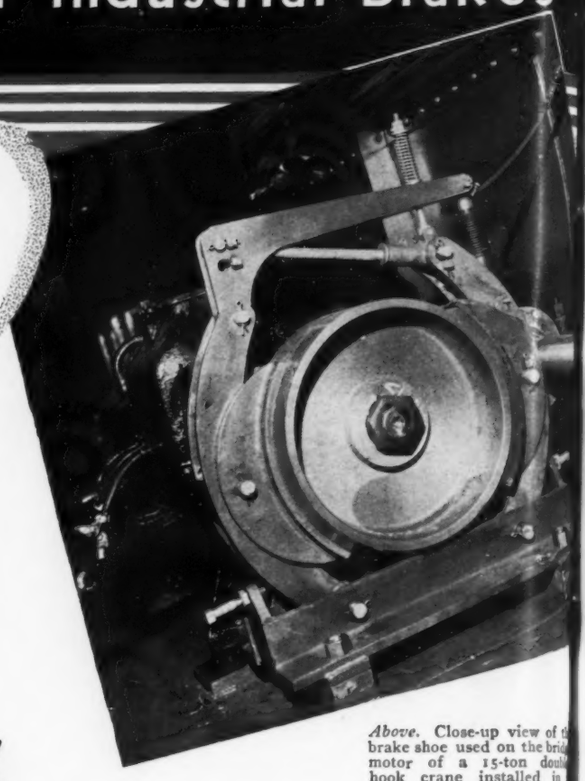


Above. Close-up view of t brake shoe used on the bri motor of a 15-ton doub hook crane installed in large steel plant. In lo right-hand corner i Wagner industr brake with hydrau actuation, type MT designed especially f steel-mill applicatio Both brakes a equipped with Wa ner CoMaX bra lining.

Note the deep-seated rivet in this cut-a section. Wagner CoMaX can be cou bored down to the strong wire backing seat the rivets directly on the wire. T the amount of lining available for bra service is considerably increased, per ting longer service for equal lining th ness than that available with other type lining. For example, in a Wagner Co block ½-inch in thickness, the rivets ca seated to within 1/16-inch for wear be the rivet-heads touch the brake-wh In other words, much as 87½% the material in inch lining is a able for bra ser

Specify Wagner CoMaX Industrial Brake Lining

Wagner CoMaX brake lining is preformed in blocks to fit all types and makes of industrial brakes. The blocks save installation time and reduce inventory.

Wagner CoMaX is non-abrasive—hence, wherever installed, scoring of brake wheels is a matter of the past. Wagner CoMaX is exceptionally long-lived—cuts down maintainance, lowers overhead, lessens shutdowns for replacement of brake wheels and brake lining.

All CoMaX blocks are wire-backed, permitting deep-seating of rivets and increasing the depth of lining available for braking service.

Visit Wagner Booths Nos. 173-174 Iron and Steel Exposition Chicago, Illinois Sept. 28-29-30 and Oct. 1

Wagner Electric Corporation
Saint Louis, U.S.A.

Industrial Brake Equipment:
4900 Baum Boulevard, Pittsburgh, Pa.

B337-1

Wagner CoMaX Brake Lining Is Noted for Its Long Life and Low Maintenance

THE SUPERLATIVE PERFORMANCE

OF LE CARBONE Brushes on jobs where only performance counts has earned their position as the Standard of Uniformity, Quality, and Efficiency.

Le Carbone Brushes are backed by over 60 years experience in manufacturing and in correct application to meet individual operating conditions. This experience can help you insure dependable service on everything from the smallest auxiliary to the largest of mill motors.

LE CARBONE COMPANY, Inc.
BOONTON, NEW JERSEY
New York • Pittsburgh • Chicago • San Francisco

SPACE 163
BALL ROOM FLOOR
IRON & STEEL EXPOSITION
CHICAGO

LET US SHOW YOU LE CARBONE BRUSHES ON THE TOUGH JOBS IN THE CHICAGO DISTRICT

LE CARBONE BRUSHES

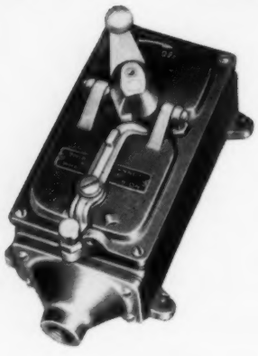
CROUSE-HINDS SAFETY

CIRCUIT BREAKER AND SWITCH CONDULETS

For Continuity of Service

STURDY RUST RESISTING

Type YSW
Circuit Breaker Condulet

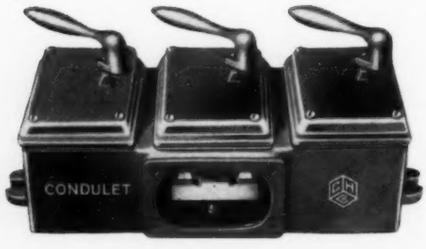


Type ZT
Safety Switch Condulet

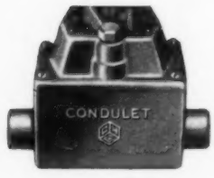
Type FLM Magnetic
Motor Starting Switch
Condulet

Type FLB
Circuit Breaker Condulet

Type FA
Safety Switch Condulet
With Watertight Cover



Type FA 3-Gang
Safety Switch Condulet
With Watertight Covers



Type EFDC
Motor Starting Switch Condulet

A Nationwide Distribution Through Electrical Wholesalers

Condulet Catalog No. 2500 will be sent on request.

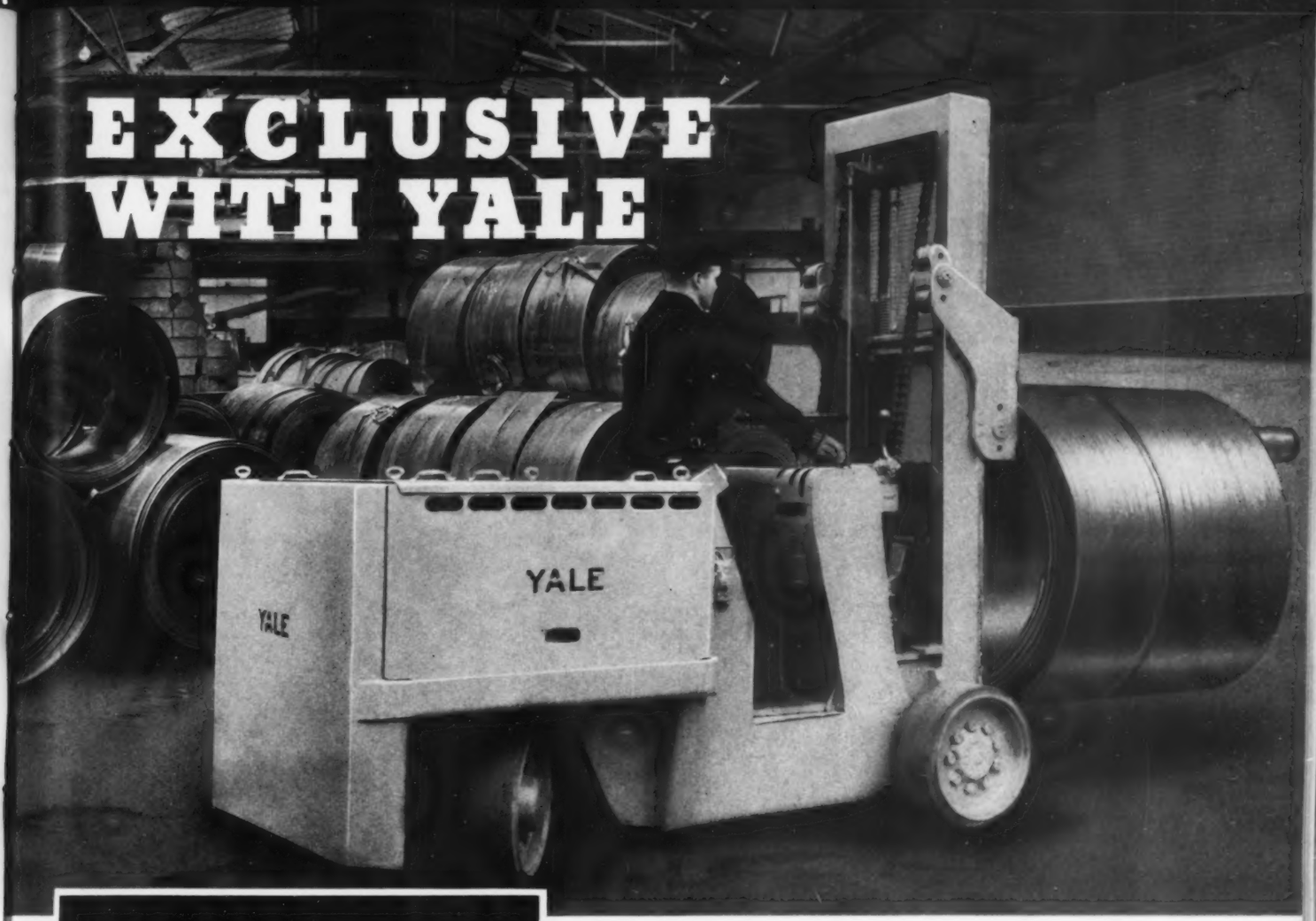
CROUSE-HINDS COMPANY
SYRACUSE, N. Y., U. S. A.

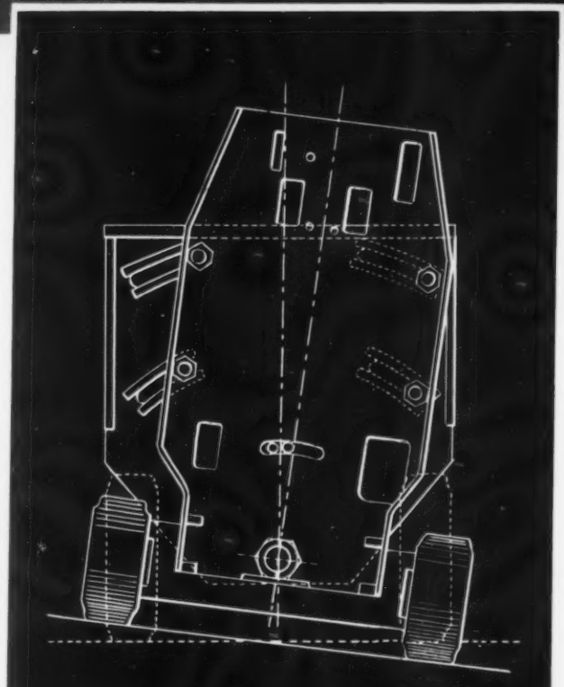
Sales Offices: Atlanta — Boston — Chicago — Cincinnati — Cleveland — Dallas — Detroit — Kansas City — Los Angeles — Milwaukee — Minneapolis — New York — Philadelphia — Pittsburgh — San Francisco — Seattle — St. Louis — Washington

CH630

CROUSE-HINDS Exhibit will occupy spaces Nos. 154 and 155 at the Iron and Steel Exposition, Chicago, Ill.

EXCLUSIVE WITH YALE





Diagrammatic view illustrating the "Caterpillar Action" of the New Articulated Yale Ram Truck — Just another economy feature that is Exclusive with Yale.

ARTICULATED RAM TRUCKS!

Always the leader, Yale again pioneers a noteworthy advance in electric truck development—The Articulated Ram Truck.

Revolutionary in design—the chassis is constructed in two units with the fore and aft sections rotating on a massive king pin. This provides a "caterpillar action" that makes it possible to operate over the roughest floors without fear of torsional strain—ELIMINATES TWISTED FRAMES!

The star feature in a star truck—this supplies maintenance economy that cannot be equalled in the field today. That's why strip mills throughout the country—faced with the problem of rough and irregular floors—are fast becoming enthusiastic Yale Ram Truck users . . . And endorsers!

The Yale Articulated Ram Truck—as designed for and used in strip mill service—will be on exhibit at the Iron & Steel Exposition, Chicago, Ill., September 28th to October 1st. See it there.

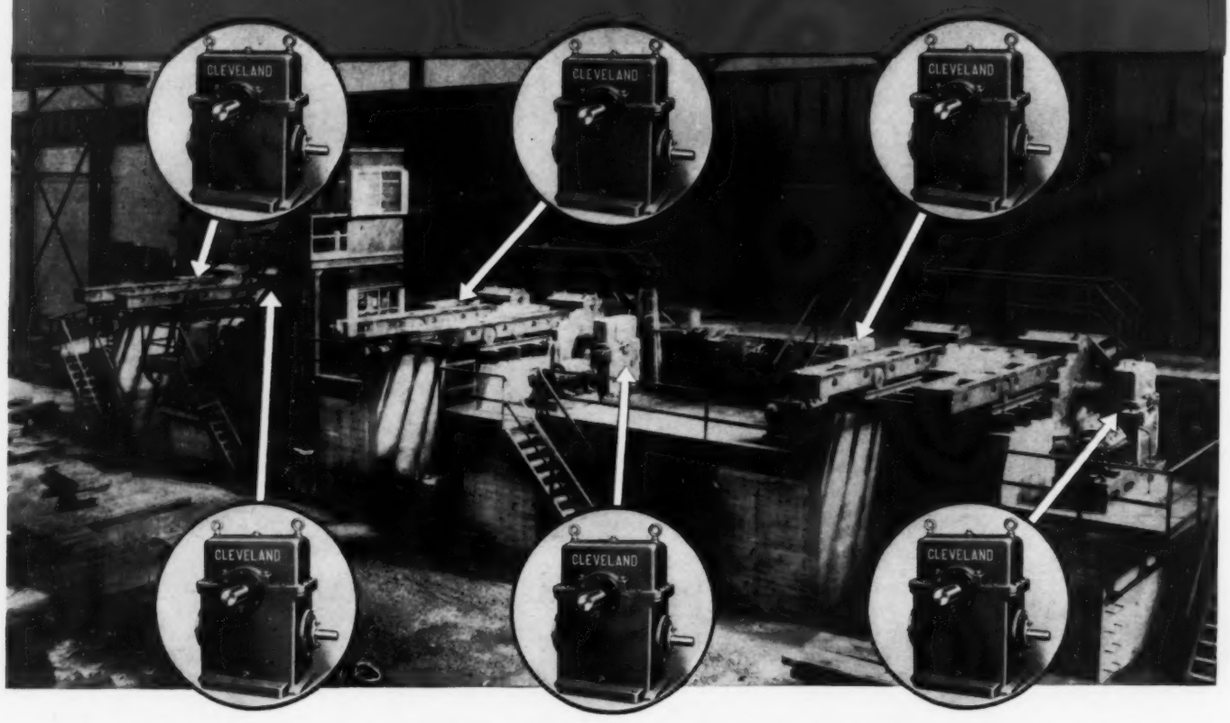
CAPACITIES: 8,000-20,000 LBS.
IN TYPES AND SIZES FOR *EVERY* HANDLING NEED

TRADE YALE MARK

THE YALE & TOWNE MANUFACTURING COMPANY,
PHILADELPHIA DIVISION, PHILADELPHIA, PA.
IN CANADA: ST. CATHARINES, ONT.

USE OF CLEVELAND DRIVES INCREASES

During 20 *Years of Improving* Steel Production Equipment



SINCE 1917, the growing demand for steel has forced increases in mill capacity amounting to nearly 20 million tons. That year is set as a base, because it was then that the first Cleveland Worm Gear Drive was sold to the steel industry—to operate open hearth furnace doors.

Immense growth in the demand for steel has spurred equipment builders to great achievement—both in redesigning established machines and in developing new ones to produce greater tonnage at sharp reductions in manufacturing cost.

It is an imposing fact that during this 20-year period, the designers of steel mill equipment have so broadened the applications of Cleveland Worm Gear Drives and Speed Reducers that, starting from *one* application in 1917, many thousands of "Clevelands" are now serving more than 225 separate applications in Steel Mills and Blast Furnace Plants.

This tremendous increase both in total number of Cleveland Worm Gear drives used and in the variety of their application bears ample testimony to the fact that the continual improvement in design and workmanship by Cleveland has kept pace with the broad development in the industry.

District Representatives in all steel-producing centers are especially informed on the Industry's power-transmission requirements, and will gladly call upon request. The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication

★ CLEVELAND *Worm Gear Drives*

Get the Best Mercury Lamp Illumination Efficiencies with Time-Proven Transformers

Above: Typical suspension type installation.

At Right: Factory lighting installation, messenger wire suspension of transformers.

Weather-proof pole mounting type transformer.

At Right: Indoor wall mounting or fixture suspension type transformer.

Weather-proof wall mounting type transformer.

● Mercury lamps, to give trouble-free, dependable performance require an accurately designed transformer to govern the current and supply the correct starting and operating voltages.

Jefferson Mercury Lamp Transformers insure continuous satisfactory operation because of their liberal design and careful construction.

Besides, they have these definite advantages and features:

- Cool
- Quiet
- Efficient
- Neat and compact
- Roomy wiring compartments
- Facilities for mounting in any position
- Combination wall mounting and fixture suspension unit
- Provided with clamps for messenger wire support.

Jefferson Mercury Lamp Transformers are fully described in new Bulletin 371-ML.

JEFFERSON ELECTRIC COMPANY, Bellwood (Suburb of Chicago), Illinois. Canadian Factory, Toronto, Ontario

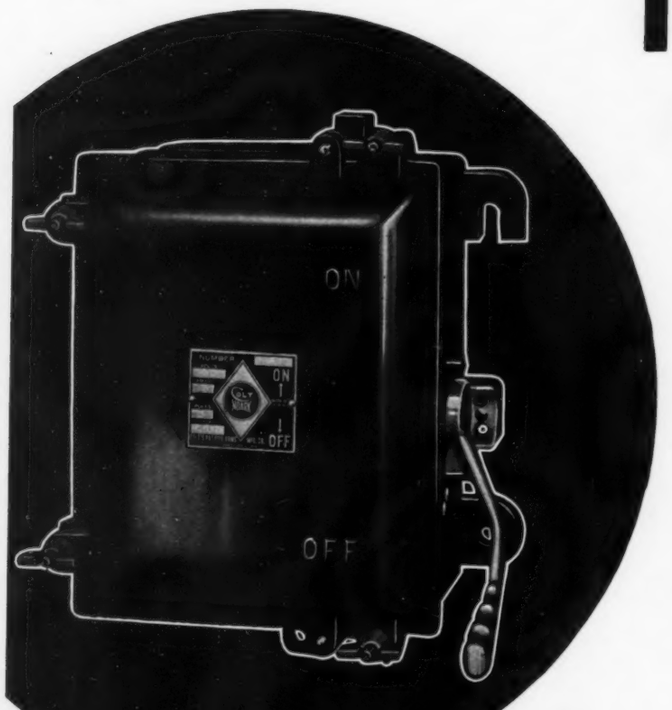
Write for New Bulletin 371-ML.

JEFFERSON

Mercury Lamp

TRANSFORMERS

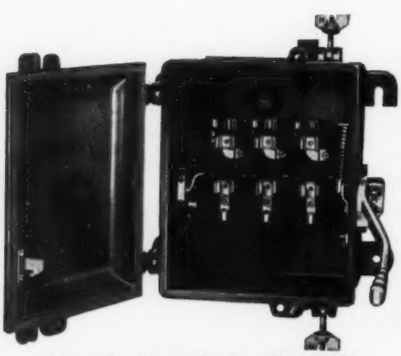
Built to TAME
the toughest job!



Dust, lint and water make life miserable for a Safety Switch . . . and so do steam and chemical vapors. It takes more than an ordinary switch to stand up under these conditions . . . and deliver dependable, trouble-free service year in and year out. But in these rugged Colt-Noark Weatherproof and Dust-tight switches you have a switch that is *designed* for just this type of abuse.

Next time you have a job that looks particularly tough, put in these hard-boiled Colt-Noarks . . . they'll tame it!

COLT NOARK
Dust Proof and Weatherproof Switches



Above is shown Catalog No. 99236, both open and closed. Note the rugged cabinet . . . the compact, simple construction of the switch unit . . . and the generous wiring space at both top and bottom.

AVAILABLE with fusible and non-fusible DUALBREAK mechanism . . . with quick-make, quick-break and interlocking covers. Either cast iron or cast aluminum cabinets . . . with covers securely fastened by extra heavy corrosion-proof eye-bolts and wing nuts. The metal handle operates in dust-tight bearings . . . and heavy rubber gaskets seal joints between the cover and the case. Tapped conduit holes are provided at top and bottom.

Heavy Duty Switch Mechanism . . . 230 and 575 Volts A. C. and 250 and 600 Volts D. C. Listed as standard by Underwriters' Laboratories, Inc. The mechanism is completely sealed . . . built for a lifetime of safe, dependable service. For full information write to

COLT'S PATENT FIRE ARMS MANUFACTURING CO.
ELECTRICAL DIVISION HARTFORD, CONN.
H. B. Squires Co., Pacific Coast Representative

100 Years of Manufacturing Experience is back of every Colt Built Product

COLT-NOARK
SWITCHES INDUSTRIAL CONTROL EQUIPMENT FUSES

Boston
New York
Chicago
Philadelphia

925

Visit the *Anaconda Exhibit* at the Exposition BOOTHS 187-188

There you will find complete information about the improvements in cables made by Anaconda engineers.

Like every other industry, steel depends on wire and cable for an uninterrupted supply of power. Overloaded circuits, voltage drops, heat losses and other forms of waste due to improper wiring can be economically ended by use of the modern, improved cables which Anaconda offers you. Anaconda engineers stand ready to give you every possible assistance in bringing your plant's electric circuits up-to-date. Meet us at the Anaconda Booth and see what is being done to give the steel industry more returns for the money it invests in electric power.

ANACONDA
from mine to consumer
REG. U.S. PAT. OFF.

Anaconda Wire & Cable Company

GENERAL OFFICES: 25 BROADWAY, NEW YORK CITY
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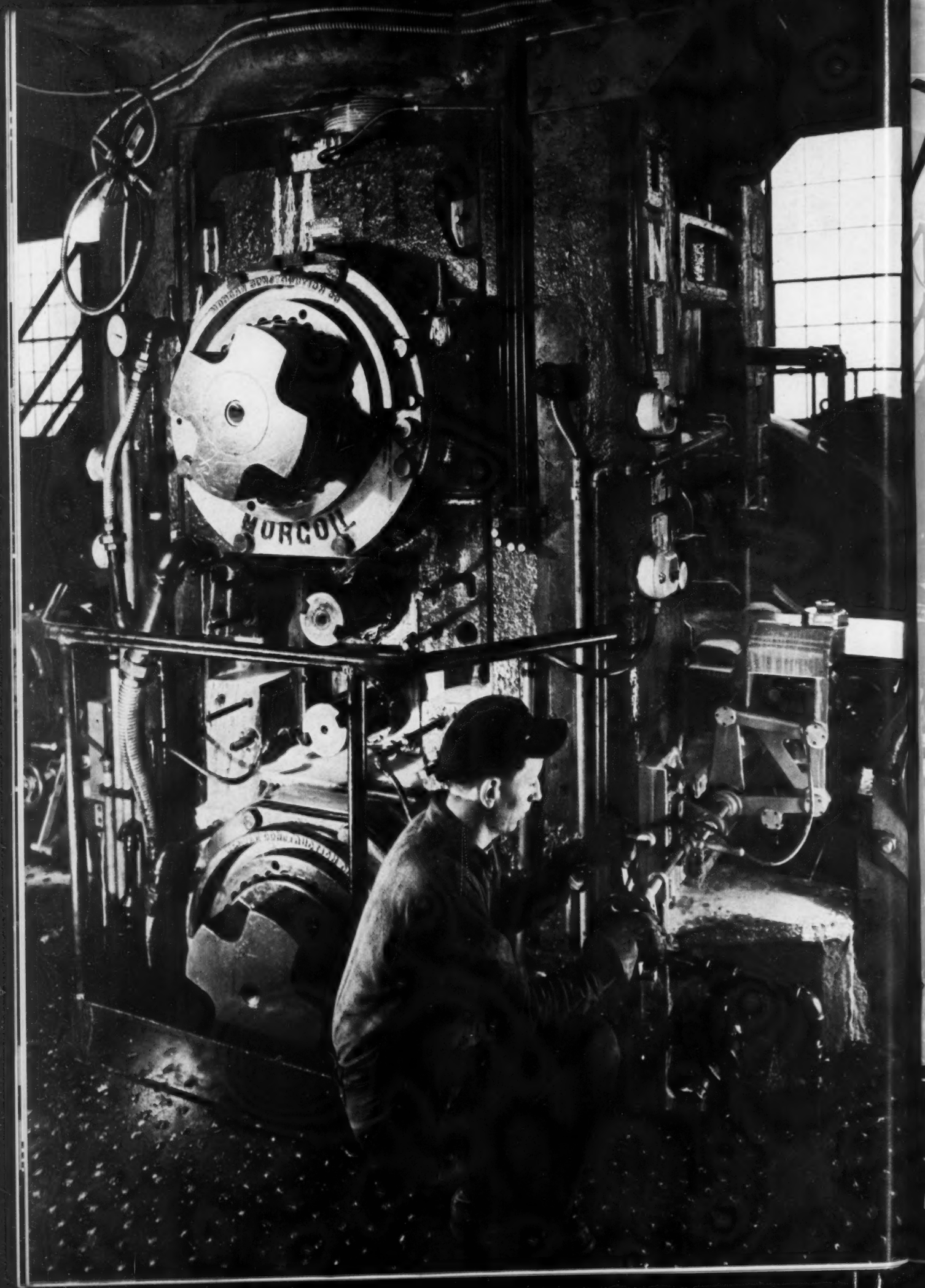

HURCO

Morgoil Bearings

STEP UP THE STANDARD

In rolling mills, where higher production and increased economy must be effected without let-down of quality, Morgoil Bearings do more than guard the standard. These mirror-finished sleeve type bearings actually make *better* quality available because they are precision built to afford utmost accuracy in the finished product. Roll settings are maintained without variance, friction is held down to a minimum, and power savings are unsurpassed.

In load carrying capacity Morgoils have no equal among roll neck bearings. The roll necks can be maintained up to 70% of roll barrel diameters. This type of bearing is available for roll sizes of 8 to 60 inches, for hot or cold mill installations.

The remarkable efficiency and long life of Morgoil Bearings testify to the soundness of design and manufacture that has characterized *complete* Morgan rolling mills for many years.

MORGOIL BEARINGS are protected by U. S. and foreign patents

BERT YARNALL RITCHIE
R27

MORGAN
WORCESTER
ENGINEERS AND MANUFACTURERS

Morgoil Bearings

MORGAN CONSTRUCTION COMPANY • WORCESTER, MASS., U.S.A.

WORLD'S LARGEST MECHANICAL DRAFT FANS!

For Logan Plant—Appalachian Electric Power Co.

Sturtevant
SIGNIFICANT!
Sturtevant Mechanical Draft Equipment has been selected for, or is now used by, a majority of the country's leading power plants!

1 Fan shown, one of two, will handle 415 tons of combustion gas per hour.

2 Operates at peripheral speed of 4½ miles per minute.

3 Will serve world's largest high pressure boiler—1,000,000 pounds of steam per hour at 1425 pounds pressure, 925°F. temperature—built by Combustion Engineering Company.

4 Total of four Sturtevant Forced and Induced Draft Fans now being installed in this record plant will handle total of 1450 tons of gas and air per hour.

Illustration shows one of two world's largest Sturtevant Mechanical Draft Fans for the Logan Plant of the Appalachian Electric Power Co.—on test at the plant of B. F. Sturtevant Company. Shown in photograph are (*left*) S. N. Fiala, (*right*) Professor Theodore Baumeister, Jr., both of the American Gas and Electric Co., and J. Cassie, Research Dept., B. F. Sturtevant Co. (*center*).

B. F. STURTEVANT CO., Hyde Park, BOSTON, MASS.
Branch Offices in 40 Other Cities
B. F. Sturtevant Company of Canada, Limited—Galt, Toronto, Montreal

Sturtevant
REG. U. S. PAT. OFF.
Puts Air to Work

DRAFT FANS · TURBINES · GEARS · ECONOMIZERS · AIR HEATERS

229

"hew to the line"

● Years of the life of every good mechanic have been spent as an apprentice, to prepare himself to "hew to the line" in his chosen trade.

Years of effort have been spent by the chemical and mechanical laboratories of The Pure Oil Company—developing, testing and checking its industrial lubricants to meet particular needs.

These products properly selected and correctly applied will "hew to the line" set for them by the Pure Oil Industrial Engineers.

Ask one of these Pure Oil Engineers to make a survey of your plant. We believe it will be to your advantage.

• • •

Comprising Pure Oil's Three Point Service is: 1) Selected Crude, 2) Skillful Refining and 3) Scientific Application.

THE PURE OIL CO.

U. S. A.

PRODUCERS, REFINERS, MARKETERS OF A COMPLETE LINE OF PETROLEUM PRODUCTS

MILLION TON PRODUCTION

with VIM

Skelp mill drives manned with VIM Leather Belts have broken all tonnage records! Above is one that has passed a million tons and still going strong. You well know it's the cost of belting per ton of steel that counts.

Many a belt has been tried and found wanting on these killing rod mill drives. Recently we learned of a competitive belt that was removed because it failed to deliver even one-half the tonnage the average VIM belt provides.

Reasons why are self-evident to the man who knows VIM—its hide origin, its care in tannage and manufacture, its rigid inspection.

There's a book that tells the story, and helps your belt man because it's full of practical transmission data. Write for "How to Belt Your Drives for More Profit."

●

E. F. HOUGHTON & CO.

Chicago - PHILADELPHIA - Detroit

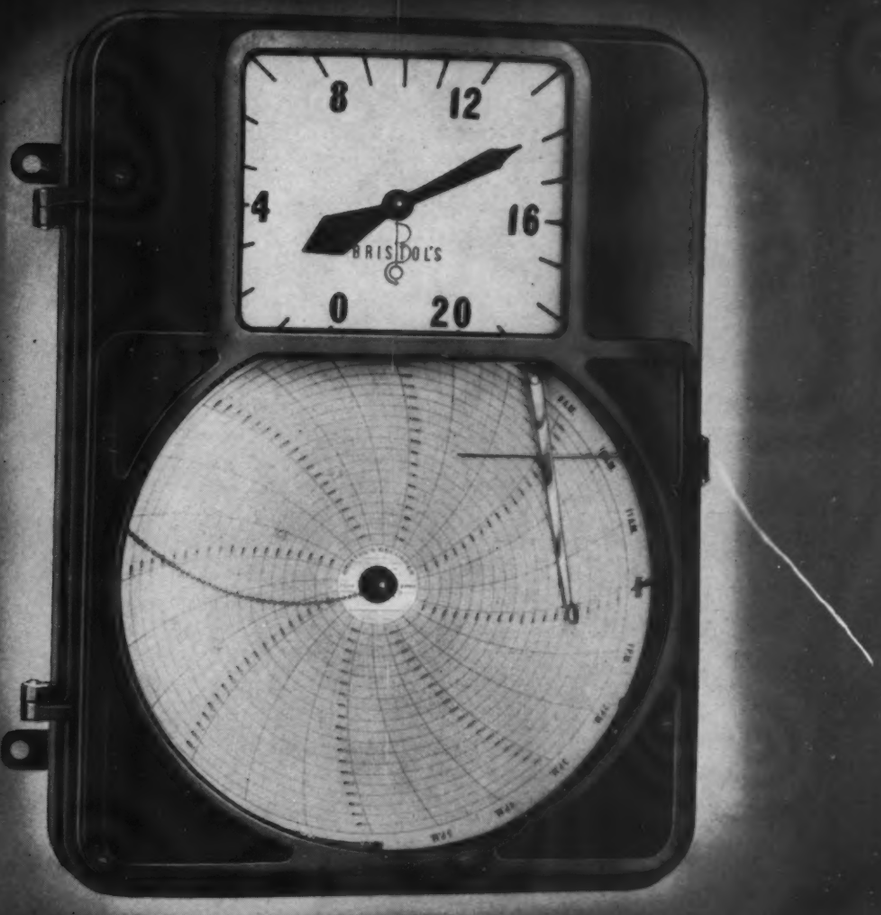
(Remember, too, that VIM Leather Packing Service is highly regarded by steel men; you can use it!)

VIM TRED LEATHER BELTING

BRISTOL'S

PYROMASTER

Round Chart RECORDING POTENTIOMETER Direct Ink Marking



New, simplified mechanism
No lubrication needed
Unaffected by vibration
High accuracy—Low maintenance
Easy to check accuracy
No motion except when readings change
Write for Bulletin 489

THE BRISTOL COMPANY, WATERBURY, CONNECTICUT

OFFERED AS A PYROMETER, RESISTANCE THERMOMETER, TACHOMETER, MILLIVOLTMETER

STEAM PRESSURE REDUCER
Boosts Gas Pressure

This DE LAVAL STEAM TURBINE

in expanding process steam from 125 lb. to 10 lb. per sq. in., develops 810 hp.

●

THE DE LAVAL FIVE-STAGE BLOWER

which it drives at 4000 r.p.m. raises 16,700 cu. ft. per min. of 0.62 gravity gas from atmospheric pressure to 10 lb. per sq. in. ● The fuel cost of this 810 hp. is small indeed, as the turbine removes from the steam only the heat actually converted into shaft horsepower; in other words, about 2545 Btu., per hp. instead of the 9000 to 12,000 Btu. taken by a condensing turbine. ● Industrial plants offer many opportunities for producing low cost power from steam used at low pressure. Where turbines or engines are already installed, similar economies are gained by superposing a high pressure boiler and turbine, the latter exhausting into the existing steam mains.

✓ **DATA ON POWER UNITS**

for various conditions which will enable you to prepare accurate estimates of savings will be supplied upon request.

3503

DE LAVAL *Steam Turbine Co.*
TRENTON, N. J.

MANUFACTURERS OF STEAM TURBINES, PUMPS – CENTRIFUGAL, PROPELLER, ROTARY DISPLACEMENT, CENTRIFUGAL BLOWERS AND COMPRESSORS, WORM GEARS, HELICAL GEARS, HYDRAULIC TURBINES AND FLEXIBLE COUPLINGS • • • SOLE LICENSEE OF THE BAUER-WACH EXHAUST TURBINE SYSTEM

Trumbull says . . .

WE HOPE TO SEE YOU

at **BOOTHS 87** *and* **88**

at the **IRON** *and* **STEEL EXPOSITION**

IRON-*clad regulations for Trumbull inspections insure perfect switch parts, accurate assembly* **AND** *a rugged line of heavy duty switches in* **STEEL** *boxes, which together with modern design win instant approval from every* **ENGINEER**

Specify Trumbull Switches for Trouble-free Operation

The TRUMBULL ELECTRIC MFG. CO.

PLAINVILLE CONNECTICUT

NEW YORK • CHICAGO • BOSTON • DETROIT • ATLANTA • PHILADELPHIA • LUDLOW, KY. • SAN FRANCISCO, CALIF. • LOS ANGELES, CALIF. • SEATTLE, WASH.

THE LAST IN A SERIES OF ADVERTISEMENTS DISCUSSING QUALITY

Okonite Wires and Cables *are Quality Products*

Experience has proven that "Okonite Quality" is a *tangible* quality—an actual difference in the properties of insulation which can be definitely measured in the reduced cost of maintaining or replacing wiring or power circuits. This quality is no mere accident. It was woven into the very beginning of this company in 1878. It has been handed down from one generation to another, for more than half a century. It is based on the use of only the finest of raw materials and longer manufacturing methods than are commonly used. It is safeguarded by constant research and development. Okonite Quality is built into every foot of wire and cable that leaves the plant. Okonite Quality is responsible for the fine operating record of Okonite Products everywhere. Okonite Quality will always be maintained.

OKONITE **THE OKONITE COMPANY** Founded 1878 *and* HAZARD INSULATED WIRE WORKS DIVISION

THE OKONITE-CALLENDER CABLE COMPANY, INC.

EXECUTIVE OFFICE: PASSAIC, N. J.

New York Boston Chicago Detroit
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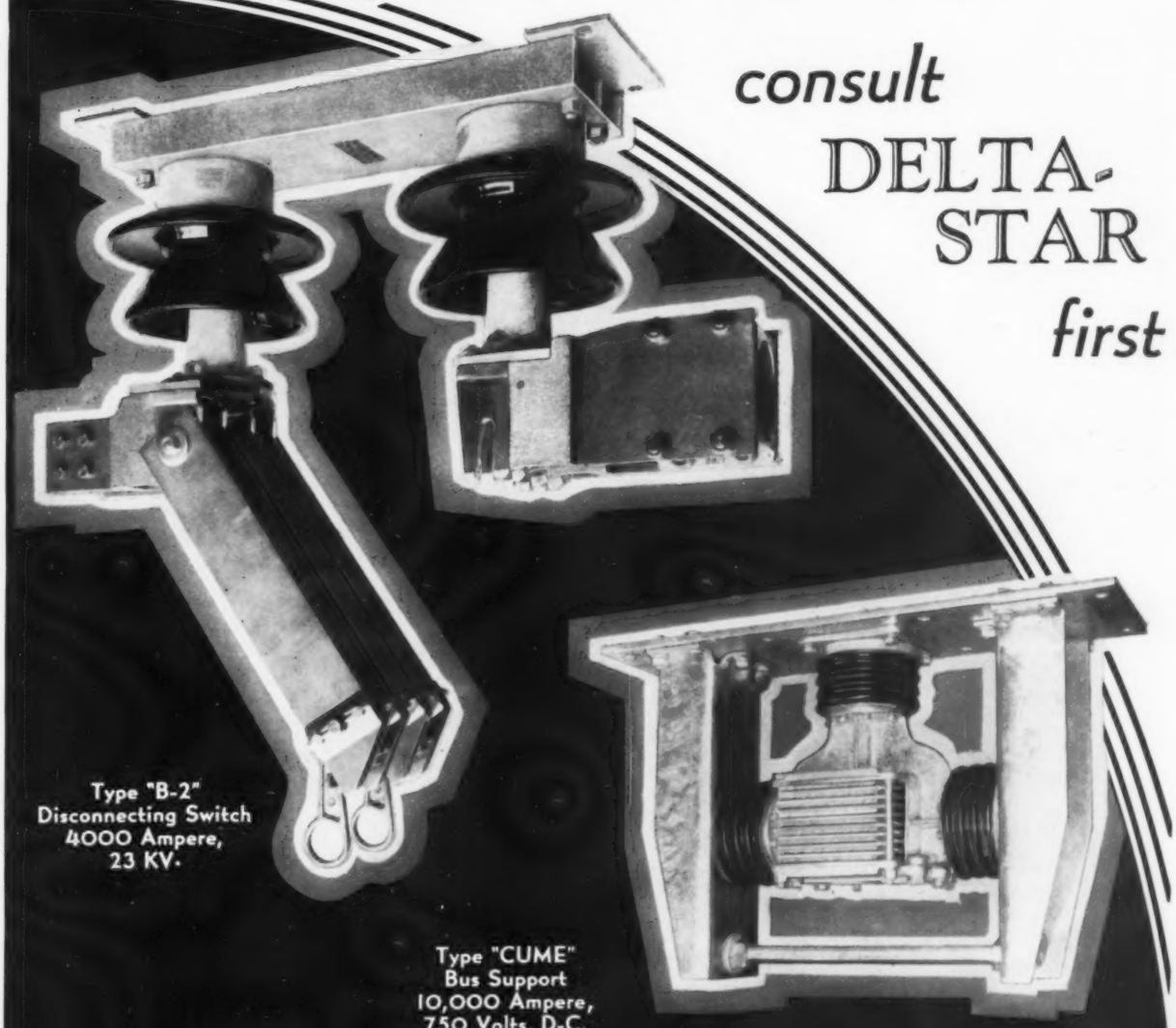
Factories: Passaic, N. J. Wil. es-t arre, Pa. Paterson, N. J.

235

For **HEAVY — DUTY EQUIPMENT**

consult DELTA-STAR *first*



Type "B-2" Disconnecting Switch 4000 Ampere, 23 KV.

Type "CUME" Bus Support 10,000 Ampere, 750 Volts, D-C.

DELTA-STAR ELECTRIC CO.

2400 Block, Fulton St. Chicago, Illinois

Pennsylvania
THESE
...in furnace transformers

PENNSYLVANIA TRANSFORMERS

Overload Capacity

Very frequently, furnace transformers are called upon to carry heavy overloads for long durations. Pennsylvania Transformers have as high as 50% of total cooling surface of copper exposed directly to cooling oil, thereby permitting heavy overloads with safety!

Ability to Withstand Short Circuits

Contrary to general belief, Furnace Transformers have a very *low* inherent impedance but at the same time must be built to withstand heavy short circuits. To complicate matters a large portion of the primary winding must be cut out of service to take care of a wide range of secondary voltages. Pennsylvania Furnace Transformers are ingeniously designed to reduce to a minimum the radial and axial short circuit stresses under all voltage conditions.

Protection Against Built-Up Voltages

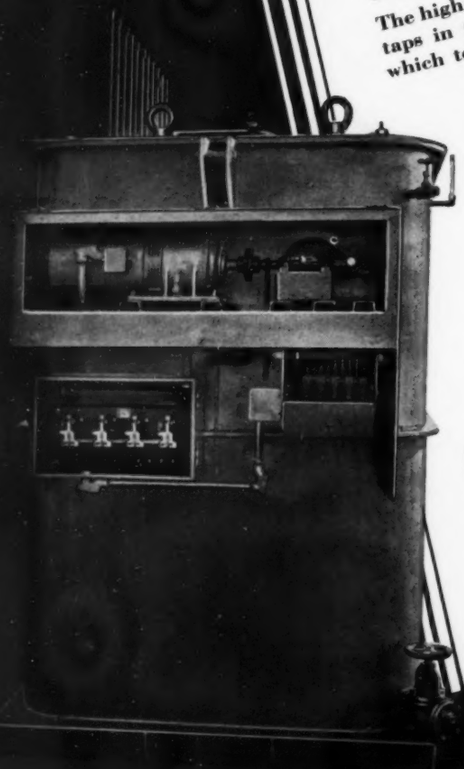
The high range of secondary voltages which is obtained by taps in the primary winding results in an auto-action which tends to build up the voltage across the primary. In Pennsylvania Furnace Transformers these taps are connected to a straight-line tap-changer, the spacing of the jaws increasing in proportion to the increase in voltage. (Only Pennsylvania's straight-line tap-changer possesses this important quality.)

Ideal Cooling Arrangement

Practically all Pennsylvania's large furnace transformers are water-cooled. The cooling coils are arranged in a single layer extending from top of tank to bottom of windings, thus forcing the cool oil to the under side of the transformer coils and providing highest cooling efficiency.

Individual Secondary Terminals

The leads of the heavy secondary windings are brazed on directly to copper bus bars which issue through the cover as individual terminals, to which the furnace leads are bolted. This insures positive, reliable contact, reduces losses and minimizes heating.



Pennsylvania Transformer for steel-melting electric furnace with remotely controlled motor-operated tap-changer.

OLD *RED-HOT*

Whether he goes into action as a rip-roaring bonfire or an invisible 200° F. *(or higher)* ambient, this symbolic sizzler is up to no good. His pet hobby is to burn or heat-rot wire insulation just for the fun of seeing you replace the wire when it fails . . . and then he goes back and does it all over again *if you let him.*

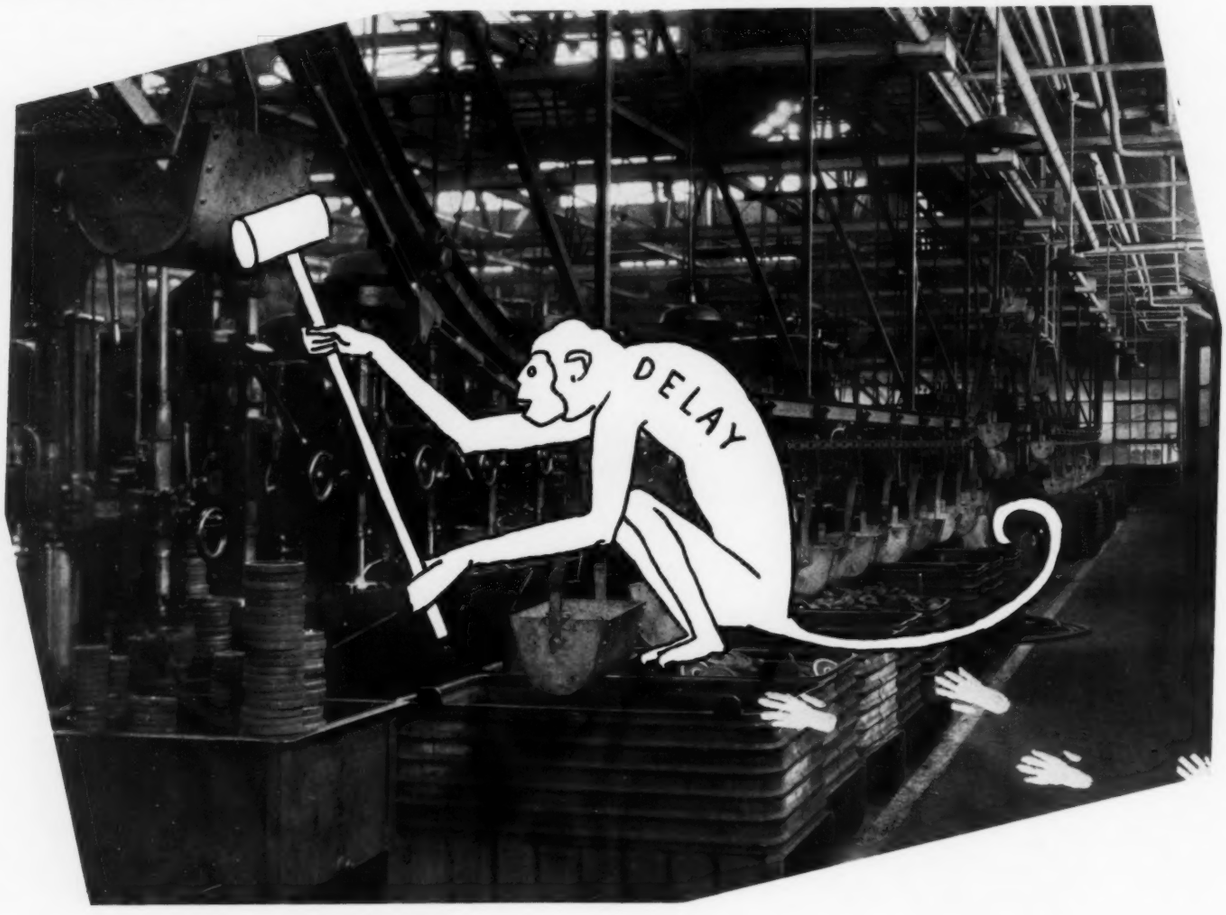
You can beat the old boy at his own game by giving him wire to work on that he can blast until he's red in the face *without injury to the insulation* . . . Rockbestos! It stops him cold because it's made of specially processed asbestos, and if you've ever used any you know that heat and fire don't bother it at all.

Rockbestos wires, cables and cords are made in more than fifty different standard constructions for heat-exposed installations. Our research laboratory can take care of special requirements. And, if you don't know what Rockbestos is, send for samples and a No. 10-D catalog. Rockbestos Products Corporation, 861 Nicoll Street, New Haven, Connecticut.

Also refer to Electrical World Buyer's Reference Number of Dec. 19, 1936. Part II.

ROCKBESTOS A.V.C.—*the wire with permanent insulation*

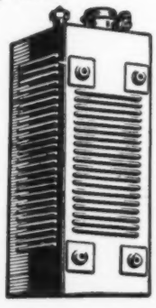
DELAY WRECKS EFFICIENCY—



STOP IT!

What has the motive power of industrial trucks to do with delay? Plenty! Trucks themselves rarely fail. But take care in selecting the power. Keep clear of the kind that starts with a jerk... and vibrates. Vibration is the root of delay. It shakes even the best trucks loose... starts breakdowns. Battery power ends this. Without question it is the least troublesome. Battery power is smooth as a swan.

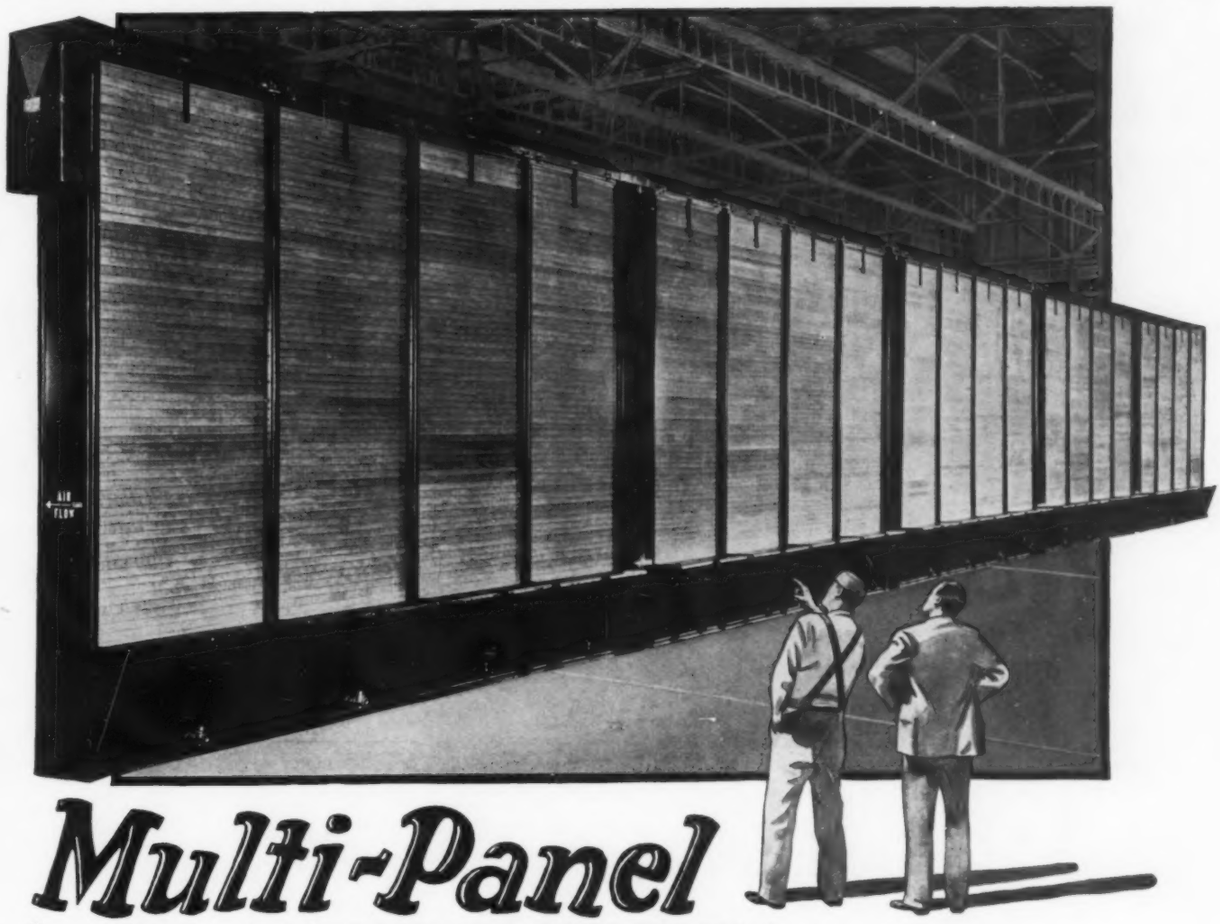
When you say industrial truck battery, most people think of the Edison Steel-Alkaline. For, it protects over 50% of trucks against delay. No other motive power source has such reliable working habits. You can charge and discharge it without the slightest worry. It lives 100% to 400% longer than any other. That's because it's steel, inside and out. All active materials are locked in steel... can't get out. The Edison is so healthy and strong it stops delay in its tracks.



EDISON STORAGE BATTERY

DIVISION OF THOMAS A. EDISON, INC., WEST ORANGE, NEW JERSEY

THE STANDARD OF COMPARISON



Multi-Panel
for MILL MOTOR PROTECTION

Iron and steel electrical engineers consider the use of MULTI-PANEL as standard practice for cleaning the cooling air for electrical equipment. . . . *proof* . . . . MULTI-PANEL is now used in 95 per cent of all steel mills having main drive motors.

MULTI-PANEL is a steel mill filter—designed especially to meet steel mill requirements and built to withstand steel mill service . . . *proof* . . . eight years of continuous operation with from two to nineteen installations in every mill in which they have been used.

Send for "American Air Filters in Industry", which gives detailed information on savings that American MULTI-PANEL filters have effected for the largest companies in the iron and steel industry.

AMERICAN AIR FILTER COMPANY, INC.
INCORPORATED
334 Central Avenue, Louisville, Ky.
In Canada—Darling Brothers, Ltd., Montreal, P. Q.

Saves

. . by permitting continuous full load operation of motors or generators.

. . by eliminating costly shut downs for removing dust deposits.

. . by lowering upkeep costs and maintaining high operating efficiency.

AMERICAN AIR FILTERS

IVANHOE

ALZAK ALUMINUM REFLECTORS

Higher Lighting Efficiency

Better Distribution of Light

More Accurate Control of Reflectivity

These vital advantages of the new low bay Ivanhoe ALZAK aluminum reflectors are of such high importance to industry that it will pay you to investigate them now. Low maintenance cost; no breakage; no chipping; and easy cleaning, are other important advantages.

Permanently high lighting efficiency is their supreme advantage, but do not overlook the fact that, even from exceptionally wide spacing of units, you get new standards of UNIFORMITY of ILLUMINATION.

The complete engineered Ivanhoe ALZAK aluminum line of reflectors includes high mounting units, angle type reflectors and reflectors for mercury vapor lamps; dust-proof reflectors, etc. Meets every need of industry.

Write at once for brochure giving complete information about this new, and more efficient, lighting equipment—backed by Miller engineered lighting service.

THE MILLER COMPANY
MERIDEN, CONN.
PIONEERS IN GOOD LIGHTING SINCE 1844

"Why not heat it ELECTRICALLY?"

Be modern *Specify* CHROMALOX UNITS

ELECTRIC HEAT as provided by CHROMALOX units is handily applied . . . inexpensive in first cost . . . economical in operation . . . automatically controllable as to temperature . . . uniformly maintains the right heat for the job . . . reduces fire hazard and insurance premiums . . . and usually is a major factor in obtaining higher, more uniform quality of product. Here is a group of outstanding advantages far beyond the capabilities of any other source of industrial heat. *Why not put this to the test?*

Take any heating job you have — perhaps a cleaning tank, vat, sterilizer, plastic molding equipment, drying oven, or a space heating job. Lay it on the doorstep of the Wiegand engineering department. A short description and pencil sketch is all our engineers need to turn their broad and successful experience loose upon your problem. They will suggest the unit to use, the best method of its application, the amount of power required, and all other details to enable you to figure the savings that Chromalox electric heat would achieve. This service carries no obligation.

You can get these units in many standard forms, developed for and successfully handling thousands of jobs of heating fluids, compounds, metals, air, gases — anything in fact that industry requires to be heated.

Special forms and types of CHROMALOX electric heating units are also available or can be quickly developed, should the job require them.

The big point is that CHROMALOX service starts from scratch, from the earnest cooperation of a versatile and experienced engineering staff, to the quick shipment of exactly the electric heating equipment you need, complete with controls, etc., as required. The character of this service has made many friends for CHROMALOX units.

MAIL IT NOW!

This coupon brings the 64 page Chromalox Catalog and handbook of electric heat . . .

Mail with your letterhead

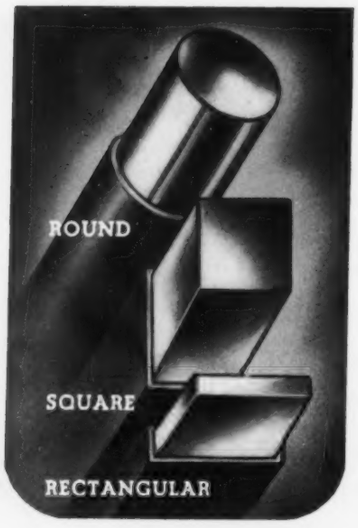
EDWIN L. WIEGAND CO., 7547 Thomas Blvd., Pittsburgh, Pa.

☐ I want to heat . . . . . Attached are sketch and description

☐ Send me the Chromalox Book of Electric Heat

Name . . . . . .

Position . . . . . .



But it's never too hot for Deltabeston

No matter what the season, motors in industrial plants run hot. Constant operation and frequent overloads keep temperatures above average. It's important that these motors be wound with magnet wire that is unaffected by heat . . . Deltabeston Magnet Wire.

Purified, Felted Asbestos contains a higher percentage of inorganic material than any other known insulation. Windings of Deltabeston Magnet Wire can be operated at a heat beyond the temperature limits of bearings.

In your plant, guard the performance of your motors with dependable Deltabeston. Smooth the road to profits with truly PURIFIED Asbestos insulation.

For complete information and samples, write to Section Y-69, Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut. Deltabeston Wire and Cable is distributed by General Electric Merchandise Distributors and Graybar Electric Company.

GENERAL ELECTRIC

DELTABESTON WIRE and CABLE

APPLIANCE AND MERCHANDISE DEPT.
GENERAL ELECTRIC COMPANY
BRIDGEPORT, CONNECTICUT

243

"Wheel Holidays"

cost you Money here!

"WHEEL Holidays" occur when the machine shop closes down for crane wheel maintenance. Keep them to a minimum, and you avoid needless interruptions in the flow of work. You speed up shipments. Your men work full days and full weeks. You conserve profits.

Machine-shop superintendents have found that they can cut "Wheel Holidays" to less than half by using USS Wrought Steel "Rim-toughened" Crane Wheels. These wheels are built especially for long mileage. They outwear ordinary wheels by approximately 2½ to 1. You'll find them standard equipment on the largest, best-known cranes in the country. Specify them both for new equipment and for replacements. You'll appreciate the results.

USS Wrought Steel Crane Wheels, double flange or single flange, are furnished rough machined, finish machined, or finish machined with finish bore and keyway—rim-toughened or untreated, as desired.

Look for the letters "R.T.", stamped on the rim. They mean "Rim-toughened" by the USS process to assure lasting hardness, safety, and long wear.

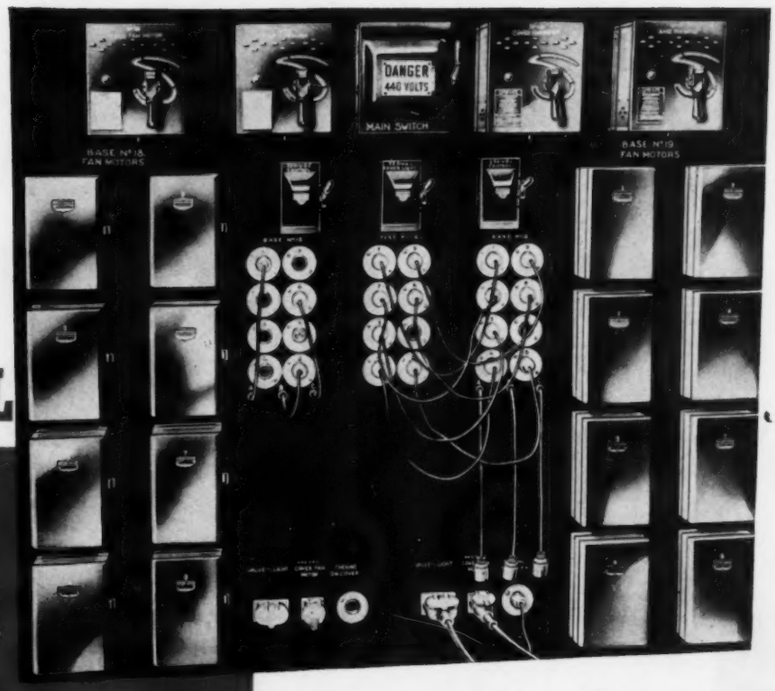
U·S·S WROUGHT STEEL CRANE WHEELS

CARNEGIE-ILLINOIS STEEL CORPORATION

Pittsburgh *Chicago*

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* — United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL



PYLE-NATIONAL

Plugs and Receptacles simplify handling of instrument circuits

Multiple Circuit plugs and receptacles, 4 to 24 poles, rated 460 volts AC, 250 volts DC, 20 amperes, and 450 volts AC, 15 amperes. Request Bulletin 193.

20 Ampere line of plugs and receptacles, 2, 3, 4, 6 poles, rated 460 volts AC, 250 volts DC, 20 amperes. Request Bulletin 179.

"QuelarC" Circuit Breaking plugs and receptacles, 2, 3, 4 poles, rated 600 volts AC, 250 volts DC, 20, 30, 60 and 100 amperes. Request Bulletin 194.

★ This control and instrument panel for portable annealing furnaces is equipped with Pyle-National 20 ampere series multiple circuit plugs and receptacles for thermo-couple connections, and "QuelarC" plugs and receptacles for valve, light, and fan motor controls.

Furnaces are equipped with 8 thermo-couples in each base and 1 in the cover. These circuits end in receptacles on the control panel. Routine temperature recording is obtained by plugging recorder leads in any 3 receptacles selected. Rapid testing of temperatures anywhere in the furnace can be obtained by connecting jumpers from the furnace leads to recorder receptacles in the center of the panel. This installation provides for normal operating procedure and special testing whenever required, with a simple, easily handled arrangement of plug and receptacle connections.

Pyle-National plug and receptacle equipment is built for heavy duty service, with full bakelite insulation, protected contacts, and heavy drawn steel or cast metal housings. The complete line includes types for all services, in a range of capacities up to 100 amperes. Bulletins with complete descriptions will be sent on request.

PYLE-NATIONAL

The Pyle-National Company, General Offices and Works, 1334-58 North Kostner Avenue, Chicago, Illinois • *Offices:* New York, Baltimore, Pittsburgh, St. Louis, St. Paul, San Francisco

CONDUIT FITTINGS • LOCOMOTIVE ELECTRICAL EQUIPMENT • FLOODLIGHT PROJECTORS

Steel gives more service!

Modern steel is produced quicker and lasts longer than the product of the past. Morganite brushes are delivered quickly without sacrifice to quality.

Steel is more uniform!

Morganite brushes continue to be uniform. Their uniformity has helped in a small way in producing the superior steels of today.

Steel uses Morganite!

Steel men attending the convention in Chicago will note the wide acceptance and increased use of Morganite brushes in this district. Why?

- *Uniformity*
- *Service*
- *Long Life*
- *Dependability*

MORGANITE BRUSH CO., INC.
LONG ISLAND CITY • NEW YORK

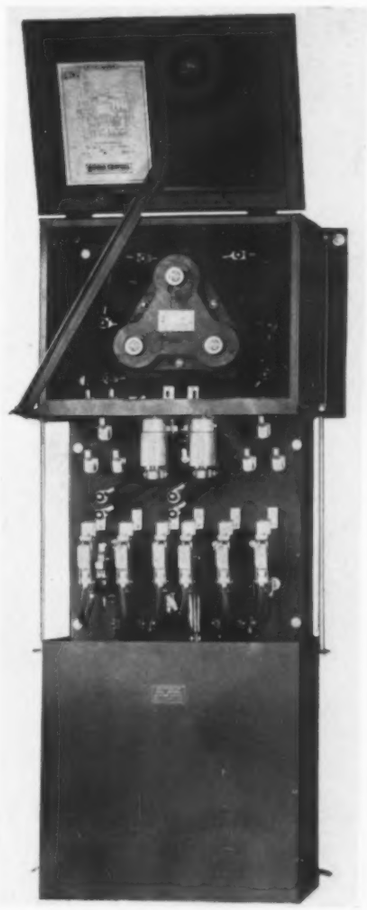
A MATCHED SET
for
Best Performance

A golfer uses a matched set of clubs for better control of his game.

The wise steel man uses matched control units for better control of his operations.

Here are the units of a perfectly "matched set" of Rowan Oil Immersed Control Equipment.

Type 620-A completely oil immersed, fused, safety disconnect switch (left) is dust tight, free from corrosion, ruggedly constructed and thoroughly dependable. Type 900-B reduced voltage impedance starter (right) has all operating parts completely oil immersed, dust tight construction, smooth acceleration, simplicity of design and is of exceptionally rugged construction.



This combination of Rowan Oil Immersed Control Equipment provides the steel man with the perfectly "matched set" for best performance.

Memo—
A personal invitation is extended to you to visit Booth #31

Illustrated bulletins containing complete information with prices are available and will be furnished promptly upon request.

ROWAN CONTROL
THE ROWAN CONTROLLER CO., BALTIMORE, MD.

X-ite

Unequalled
The manufacture of heat and corrosion resistant alloys is a young industry. Experience is in the making—but—one concern stands out alone as having unequalled experience.
General Alloys has made more industrial furnace parts than any three competitors combined.
General Alloys Co., oldest and largest exclusive manufacturer of heat and corrosion resistant castings, has the largest installations of heat treating containers with the longest heat hour service records, facts that can be readily established.
General Alloys, with twenty-four field representatives, has the only national engineering organization in the alloy business.
General Alloys' sales volume permits frequent heats of many analyses that competitors solicit orders for but seldom produce.
At the Steel Show in Atlantic City General Alloys will be the largest exhibitor in our line for the 18th consecutive year. We have shown more castings at the Steel Shows and used more advertising in A. S. M. publications than all competitors combined. See us at the Show.
If you don't get our house organ, Alloy Progress, first printed in Metal Progress and mailed to non-members of A. S. M., write on your letterhead.
Experience

BOOTH 159
IRON & STEEL EXPOSITION
CHICAGO
Sept. 28, 29, 30
October 1

Q-ALLOYS

Even if you work for one of those reciprocity-bound outfits whose purchasing and engineering departments are rubber stamps for the sales manager and couldn't buy anything if it was good, come in and commiserate.

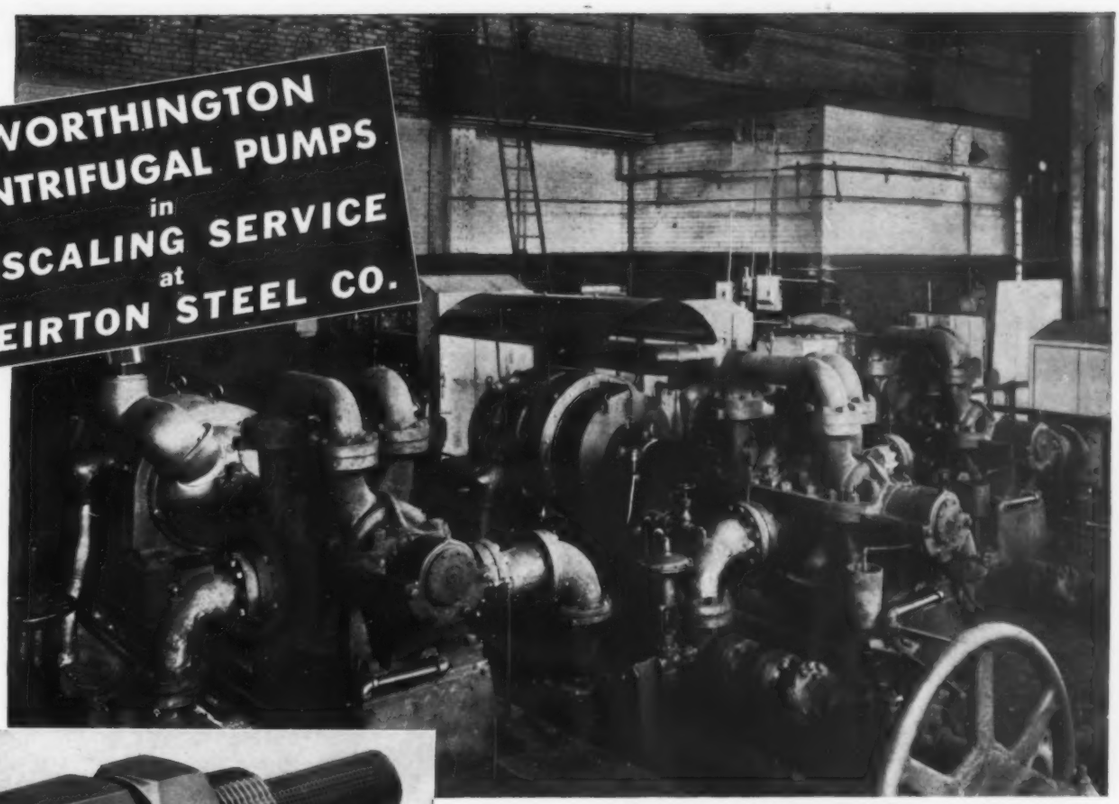
We know you don't like it any better than we do.

If you are interested in improved methods for conveying material through furnaces, or in dependable alloys and better alloy engineering, give us a chance to discuss your alloy problems and base your judgment of us on our engineering recommendations to you.

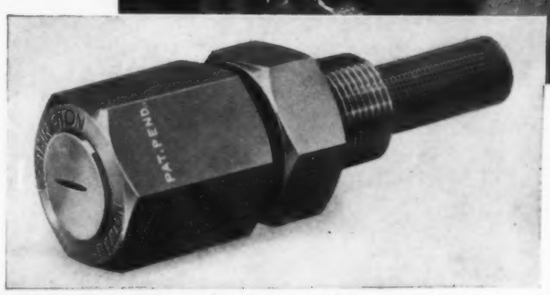
GENERAL ALLOYS CO.
BOSTON - CHAMPAIGN

BRANCHES—NEW YORK—CHICAGO—DETROIT—PITTSBURGH—CLEVELAND—PHILADELPHIA—ST. LOUIS—HARTFORD
MILWAUKEE—BUFFALO—TOLEDO—DAYTON—ALLIANCE—RICHMOND—SAN FRANCISCO—LOS ANGELES—NEW ORLEANS

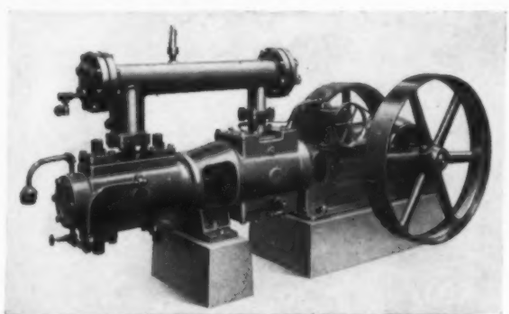
WORTHINGTON CENTRIFUGAL PUMPS in DESCALING SERVICE at WEIRTON STEEL CO.



Three Type 6-UX Centrifugals. These pumps deliver 550 g. p. m. at 1050 lb. pressure



Worthington Standard Spray Nozzles offer several exclusive features



Worthington Single Tandem Two-Stage Charging Compressor . . . 1200 lb. per sq. in. discharge pressure

COMPLETE WORTHINGTON DESCALING SYSTEMS

for any type of mill . . .

include a wide range of centrifugal and reciprocating pumping units to meet exactly the requirements of any installation.

●

WORTHINGTON PUMP AND MACHINERY CORPORATION

General Offices: **HARRISON, NEW JERSEY** - *Branch Offices and Representatives in Principal Cities throughout the World*

WORTHINGTON

ATLANTA BOSTON BUFFALO CHICAGO CINCINNATI CLEVELAND DALLAS DENVER DETROIT EL PASO HOUSTON KANSAS CITY LOS ANGELES NEW ORLEANS NEW YORK PHILADELPHIA PITTSBURGH ST. LOUIS ST. PAUL SAN FRANCISCO SEATTLE TULSA WASHINGTON

REPUBLIC EQUIPMENT

VISIT BOOTH 233 AT THE IRON AND STEEL EXPOSITION

STEAM POWER PLANTS

Flow Meters	Draft Indicators	Boiler Feed Water Control
CO_2 Meters	Temperature Recorders	Regulating Valves
Pressure Recorders	Combustion Control	Excess Pressure Control

Pressure Reducing and Desuperheating Control

COKE OVEN BATTERIES

Oven Pressure Control	Gas Mixing Control	Flow Meters
Stack Draft Control	Regulating Valves	CO_2 Meters
Flue Gas Pressure Control	Level Controls	Recording Thermometers

Pressure—Suction and Stack Draft Recorders

Suction Main and Exhauster Control

FOR THE STEEL MILL

VISIT BOOTH 233 AT THE IRON AND STEEL EXPOSITION

BLAST FURNACES

Pressure Recorders	Flow Meters	Air Volume Control
Recording Thermometers	CO_2 Meters	Gas Pressure Control

Combustion Control for Blast Furnace Stove Burners

Control Valves—Butterfly and Turbine Type

OPEN HEARTH FURNACES

Furnace Pressure Control	Gas Mixing Control	CO_2 Recorders
Combustion Control	Regulating Valves	Pressure Recorders
Furnace Reversal Control	Flow Meters	Temperature Recorders

BLOOMING MILL SOAKING PITS

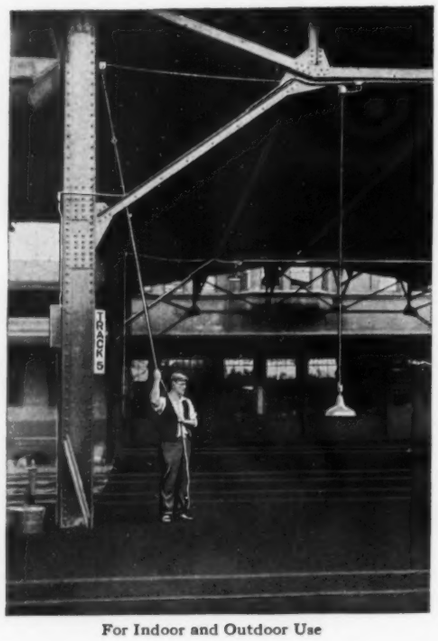
Control Valves	Gas Meters	Furnace Pressure Recorders
Gas Mixing Control	CO_2 Meters	Furnace Pressure Control
Gas Pressure Control	Recording Thermometers	Combustion Control

ROLLING MILL REHEAT FURNACES

Furnace Pressure Control	Gas Mixing Control	CO_2 Recorders
Combustion Control	Gas Pressure Control	Temperature Recorders
Regulating Valves	Furnace Pressure Recorders	Flow Recorders

REPUBLIC FLOW METERS CO.

2220 DIVERSEY PARKWAY CHICAGO, ILLINOIS



For Indoor and Outdoor Use

Even if . . .

your electric current,
lamps, etc.,

Cost you Nothing!

—the matter of greatest importance is

Adequate Illumination

in industrial lighting.

The business side of the reflector should have frequent servicing—for dirt is the greatest handicap to proper lighting.

THOMPSON LAMP LOWERING HANGER

—enables overhead lamps to be serviced with ease and in safety on the ground or floor level—automatically locked in the electric circuit when pulled up again—the advantage is obvious—inexpensive and easily included in present installations.

Handled by leading Electric Supply Houses

THE THOMPSON ELECTRIC CO.

1101 POWER AVENUE, N. E. CLEVELAND, OHIO, U. S. A.

FORTY-EIGHT BROSIUS AUTO FLOOR CHARGING MACHINES

have been supplied to the steel industry in the United States and abroad. They supply the needs of the smaller plants where expensive charging equipment is not justified.

The Brosius Charger is comparatively inexpensive, self contained, and requires no tracks or runways. It operates in congested areas as it can turn on its own wheel base.

The machine is built for serving open hearths, and similar melting furnaces, for handling slabs, billets, ingots, etc., and for manipulating pieces under hammers and presses.

OTHER PRODUCTS

Electric, Steam and Hydro-Electric Clay Guns,

Hand and Motor Operated Goggle Valves,

Cinder Notch Stoppers,

Flue Dust Conditioners.

Blast Furnace Slag Granulating Machines,

EDGAR E. BROSIUS, INC.

Engineers and Manufacturers

PITTSBURGH, SHARPSBURG BRANCH, PENNSYLVANIA

European Distributor

Dango & Dienenthal, Siegen, Westphalia, Germany

Brosius Equipment is patented in the United States and Foreign Countries

OTHER PRODUCTS

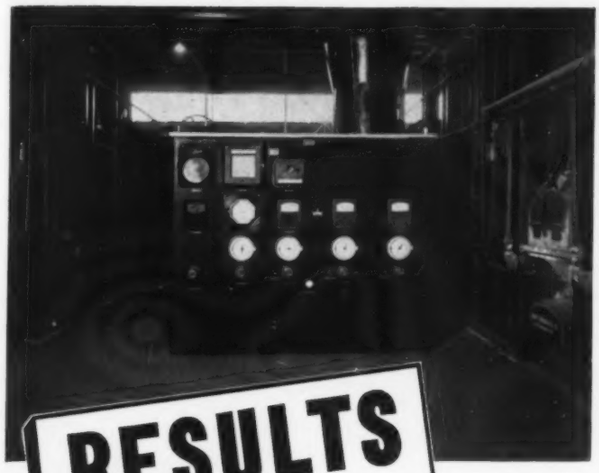
Single Hook Grab Buckets,

Automatic Dump Buckets,

Automatic Single Hoist Buckets,

Overhead Charging Machines,

Auto Floor Manipulators.



RESULTS For Sale !

The illustration shows a typical Askania Panel Board. Mounted on it are Furnace Pressure, Combustion and Gas Mixing Controls for a Slab Heating Furnace.

RESULTS are what you are after when you install automatic control—and the ability of Askania engineers to produce results are written into the operating records of hundreds of steel plants.

We offer the closest possible co-operation with the plant engineer in working out the best solution to your control problem.

We offer the tested simplicity, versatility, and soundness of the Askania Jet Pipe Principle.

We offer a thoroughness of engineering before the installation is made, that guarantees specific results after it is made.

We offer precision workmanship that assures the perpetuation of those results—with an absolute minimum of maintenance.

Results—not initial cost—are the measure of control equipment's value. You may pay more for an Askania System than for some forms of regulation, but the Askania System pays you—a lot more!

ASK FOR NEW BULLETIN

now on the press covering Askania Control applied to every phase of steel plant operation —furnace pressure—combustion—rate of flow —constant air weight delivery—mixing station control—and similar applications.

ASKANIA REGULATOR CO.
1603 S. Michigan Ave., Chicago

Automatic CONTROL *by* ASKANIA CHICAGO

If it can be measured —we can control it

TICKETS

for the various

CONVENTION ACTIVITIES

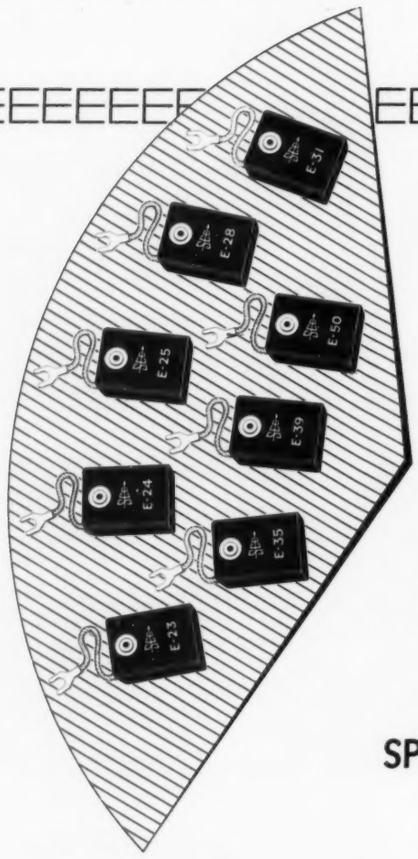
including inspection trips to the Gary Sheet & Tin Division of the Carnegie-Illinois Steel Corporation and the Indiana Harbor Works of the Inland Steel Company; the Welcome Luncheon, Tuesday September 28 and the Banquet and Dance to be held Friday evening October 1,

Will be available at the

A. I. & S. E.

Registration Desk

Stevens Hotel - Chicago, Ill.



Brush Choice *Simplified*

After more than 39 years of motor and generator brush manufacture, close study of installations, research and pioneering, Speer Series E is offered as a group of eight brushes which will give superior service in at least eighty percent of all motor, generator and rotary converter installations for public service and industrial use. They meet requirements ranging from the largest motors in steel rolling mills to the smallest fractional horsepower motors made.

Correct choice is further simplified by Speer Brush Data Forms. Write for copies—one for each machine you care to investigate.

SPEER CARBON COMPANY, ST. MARYS, PA.

SCC

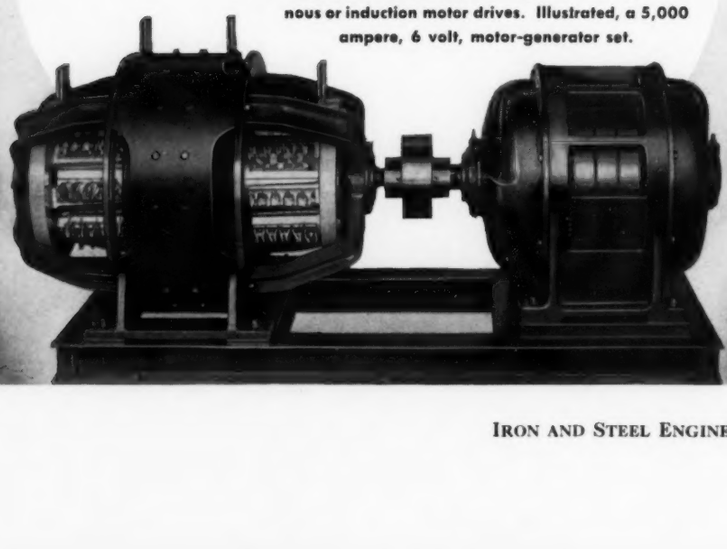
7730

ELECTROPLATING GENERATOR

performance is far more dependable today than ever before due to modern design, materials and construction. For complete information on these better built generators, write to

COLUMBIA

Capacities 100 to 20,000 amperes, with synchronous or induction motor drives. Illustrated, a 5,000 ampere, 6 volt, motor-generator set.



"Next time we need electrical connectors — let's get Burndys! They've got soldered joints beat a dozen different ways. (Bet you never heard of a Burndy Connector folding up under vibration or overload!)"

See you in Chicago! Visit the Burndy booth (No. 216) at the Iron and Steel show. See why industrial engineers and superintendents "Connect with Burndy" for safety and savings.

Burndy Qiklug type QA —installed with the turn of a wrench! Stocked in sizes up to 2000 Mcm., salvable for re-use.

Burndy Gutter Tap type QP — tighten two Everdur cap screws and this cable clamp makes a solid connection!

Burndy Bartap type QAF — for tapping a cable from a bar without drilling holes. Bolts, nuts and clamps of Everdur.

BURNDY

ENGINEERING CO., INC.

459 E. 133d STREET (B) NEW YORK, N. Y.

An Old Ohio Magnet

Bought in 1920 and just ready to be returned to the original buyer after repairs as follows:

Remachine all fits — reinsulate coil — furnish new manganese bottom plate, terminal insulation and leads and reassemble.

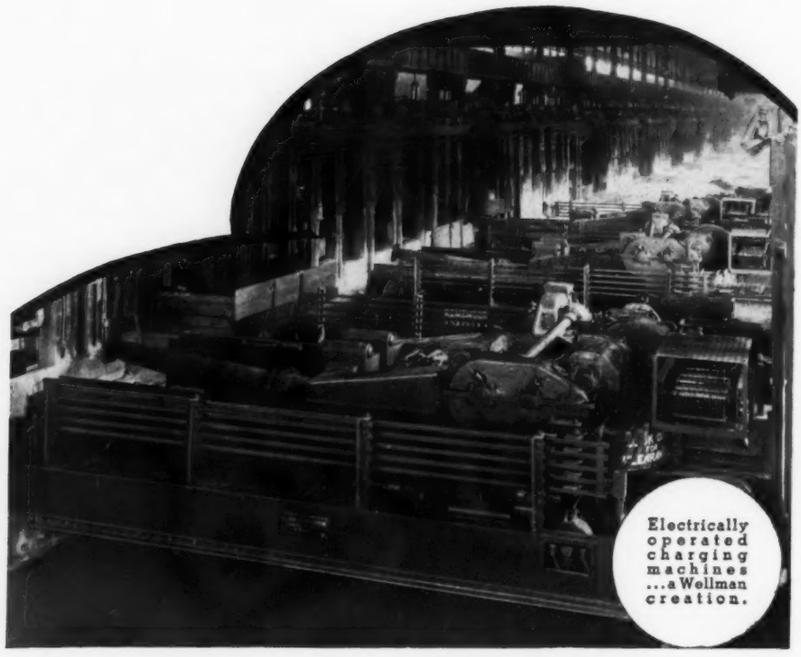
It is good now for many more years further service.

Ohio Magnets are profitable and they are now made better than ever.

What is your magnet problem?

The Ohio Electric Mfg. Co.

5907 Maurice, Ave., Cleveland, Ohio



FURNACE CHARGING Equipment.

Open Hearth Furnaces

WELLMAN PRODUCTS INCLUDE:

Mine Hoists.
Ship Unloaders.
Coal and Ore Handling Bridges.
Special Cranes.
Clam Shell Buckets.
Car Dumpers, all types.
Blast Furnace Skip Hoists.
Gas Producers, Flues and Fuel Feeds.
Wellman-Galusha Clean Gas Generators.
Gas Reversing Valves.
Furnace Charging Equipment.
Open Hearth Furnaces.
Steel Works Equipment.
Safety Stops for Traveling Structures.
Welded Steel Construction.

Wellman experience in the design and development of electrically operated charging machines and manipulators dates back to the very first machines of this type to be offered the steel industry.

THE WELLMAN ENGINEERING CO.
ENGINEERS CONSTRUCTORS MANUFACTURERS
CLEVELAND, OHIO
BIRMINGHAM • NEW YORK • MEXICO CITY
WELLMAN

Let's make medicine

the council fire is lit . . .

INTERESTING HOWS

HOW the Industrial Advertising Manager Can Function in His Public Relation Program.

HOW to Evaluate Publications—Methods of Qualitative and Quantitative Analysis

HOW to Use and Not to Use Industrial Motion Pictures

HOW to Develop and Maintain Industrial Mailing Lists

HOW to Secure Greater Effectiveness from the Advertising Dollar

HOW to Organize and Carry on Market Research Activities and How to Apply the Facts

HOW to Apply Showmanship and Add Sales Power to Industrial Copy

HOW to Write Better Letters and Use Them More Effectively

HOW! BROTHER

By smoke writing and carrier pigeon—by swift runner and heliograph, word has reached the council fire that the braves of many tribes are on the march and will assemble in full force at the big 15th Annual Pow-wow of the NIAA, September 22, 23, 24, at Chicago.

Important plans will be discussed—extensive exhibits of successful advertising and sales promotional material displayed and valuable "Hows" presented by industrial sales and advertising directors.

Of course, pleasure has had its full consideration—banquets, night clubs, bathing, golf—and bows and arrows for those who prefer.

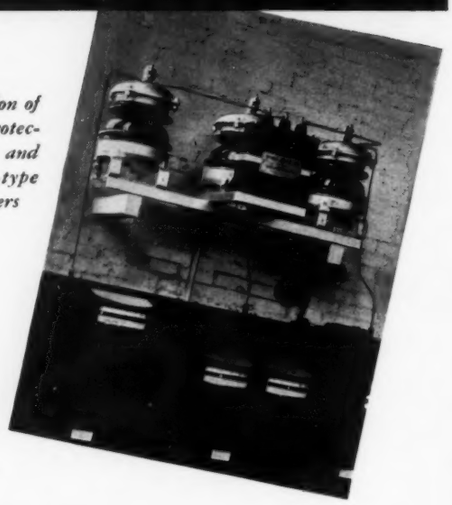
Mr. H. D. Payne, Chairman, 2145 Walnut Street, Chicago, Ill., will gladly accept your reservation or send further information—write him.

Prepared by The Buchen Company, Chicago

NIAA

15TH ANNUAL ADVERTISING AND SALES PROMOTION CONFERENCE AND EXPOSITION
EDGEWATER BEACH HOTEL, CHICAGO
SEPTEMBER 22, 23, 24, 1937

ROTATING-MACHINE PROTECTION PAYS BIG DIVIDENDS



Indoor installation of G-E Pyranol protective capacitor and special station-type Thyrite arresters

MODERN lightning protection for your a-c rotating machines can pay big dividends for a small investment. For example, on a large Southern utility system an 11,000-volt, 7000-kva generator had failed repeatedly over consecutive seasons because of lightning. Since the installation of G-E protective capacitors with arresters in 1929, no failures have occurred.

PROTECTION—*A Sound Investment*

When you consider that a single machine failure can result in a loss which is immense in comparison with the cost of protective equipment, adequate protection is plainly a low-cost insurance and a sound investment.

Generators and other rotating machinery require a *special threefold* protection—to limit surge amplitudes, wave fronts, and reflections within the machine windings. G-E protective capacitors and arresters provide this protection. They are easily installed, fixed charges are insignificant, and practically no maintenance is required. Send for complete information. General Electric Company, Schenectady, N. Y.

GENERAL ELECTRIC

General Electric, Dept. 6G-201
Schenectady, N. Y.

Send me a copy of your descriptive bulletin on rotating-machine protection. (GEA-1743B)

Name.....
Firm.....
Address.....
City..... *State*.....

330-257

EVERY SAVING BECOMES A PROFIT!

and NON-FLUID OIL saves money on both lubricant and repair cost . . .

Because it does not drip or leak NON-FLUID OIL lubricates dependably and outlasts ordinary oil 3 to 5 times.

For the same reason NON-FLUID OIL helps reduce production costs by keeping all machines in steady trouble-free operation.

Leading steel and iron engineers have adopted NON-FLUID OIL after thorough tests.

Send for testing sample today—prepaid—NO CHARGE.

●

New York & New Jersey Lubricant Co.

Main Office: 292 Madison Ave., New York, N. Y.

WAREHOUSES:

Chicago, Ill.
St. Louis, Mo.
Providence, R. I.
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Spartanburg, S. C.
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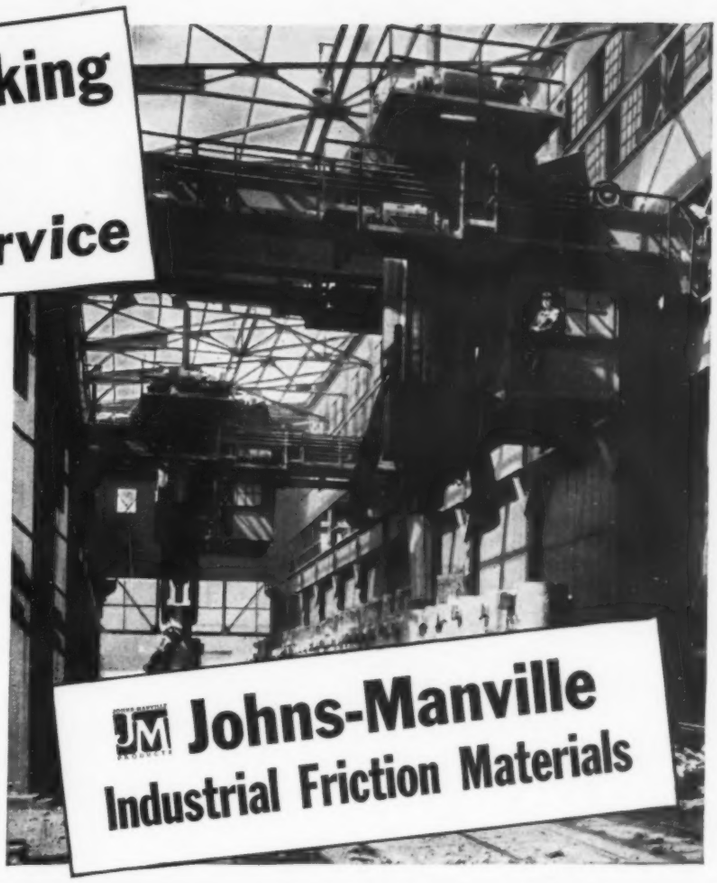
Greenville, S. C.

TRADE MARK REGISTERED
NON-FLUID OIL
IN U.S. PAT OFFICE & FOREIGN COUNTRIES

MODERN STEEL MILL LUBRICANT

Better lubrication at Less Cost per Month

Setting New Braking Standards in Steel-Mill Service



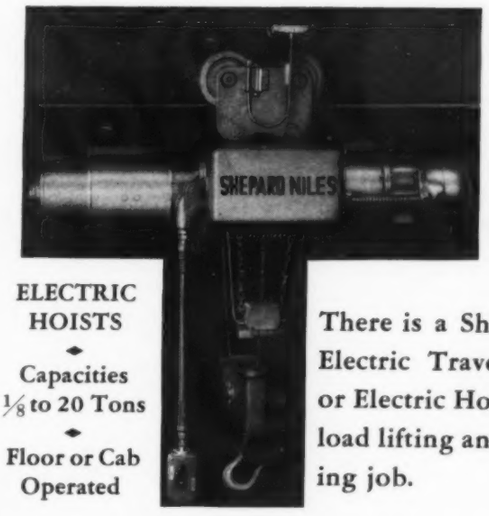
NO MATTER OF CHANCE... the standardization of J-M Friction Materials on steel-mill hoists, cranes and similar equipment. Over a long period of years, these products have *proved* their durability and dependability under the severe service conditions typical of the steel industry.

And because Johns-Manville research and rigid manufacturing control guarantee *consistently* high quality, J-M Brake Linings and Clutch Facings offer every assurance of new maintenance and power economies.

Both flexible and rigid styles to answer every steel-mill need are available in J-M's complete line of friction materials. Get full details on all of them by writing for our brochure, "Friction Materials for the Iron and Steel Engineer." Address Johns-Manville, 22 E. 40th St., N.Y.C.

JM Johns-Manville
Industrial Friction Materials

MATERIAL HANDLING EQUIPMENT



FOR THE IRON AND STEEL INDUSTRY

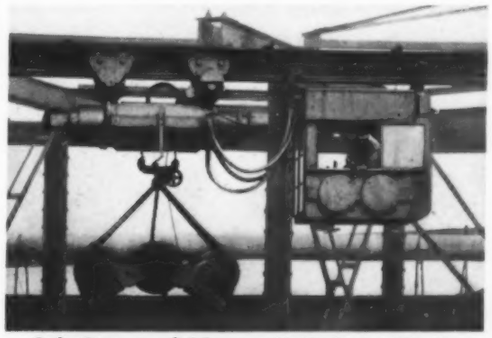
ELECTRIC HOISTS

Capacities 1/8 to 20 Tons

Floor or Cab Operated

Electric Traveling Cranes—All Types
Capacities 1/4 to 450 Tons

There is a Shepard Niles Electric Traveling Crane or Electric Hoist for every load lifting and load moving job.



Cab Operated Monorail Hoists—Single or Twin Hooks—Grab Bucket and Cupola Charging Types

SHEPARD NILES
CRANE & HOIST CORPORATION

376 SCHUYLER AVE.
MONTOUR FALLS, N. Y.

. . . and you CONTROL A VITAL FACTOR *in Heat Treating*

The ANALY-GRAPH is fool-proof, simple in operation and easily installed on any furnace—electric or fuel fired—wherein furnace atmospheres are controllable.

A constant sampling of the furnace gases directly in contact with the work is conducted by means of an analyzing unit. Briefly, the procedure is as follows:

Furnace gases are drawn through a sampling tube, drier and filter. The gases upon entering the *Gas Analysis Cell* cause the electrically heated cell to get hotter—increasing the electrical resistance. The rise and fall of electrical resistance with changes in furnace atmospheres affects the galvanometer in the recording instrument which produces a continuous record of oxidation or reduction.

Thus, the furnace man is supplied with a continuous record, on a standard 12-inch chart, of the furnace atmosphere as produced by any degree of combustion.

No longer need you wait for a report on the furnace atmosphere while work may be spoiling. Direct reading of the Brown ANALY-GRAPH measures furnace atmosphere in simple, workable terms. It gives accurate, unfailing response to variations in the atmosphere and humidity conditions—whether combustion is complete or incomplete.

To measure furnace atmospheres with the Brown ANALY-GRAPH—while work is being treated—is to *know in advance* that the final result *will exactly meet* the desired specifications. It means, further, that you can easily avoid faulty hardening . . . expensive retreatments . . . rejections due to excessive scaling, undesired carburizing or decarburizing.

The Brown ANALY-GRAPH enables you to check the exact amount of oxidation and reduction in the furnace atmosphere—for any metal—at any temperature. Thus, you have a tangible, instantaneous and continuous means of controlling quality and uniformity of result—a VITAL FACTOR in heat treating.

An outstanding advantage is that once the ideal condition is established and recorded, it can be quickly duplicated whenever desired—batch after batch—by any operator.

Other advantages and detailed descriptive data are given in Bulletin No. 92-1. Write THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Co.*, 4464 Wayne Avenue, Philadelphia, Pa. Offices in all principal cities; Toronto, Canada: 117 Peter Street—Amsterdam-C, Holland: Wijdesteeg 4 — London, England: 70 St. Thomas' Street, S.E.1.

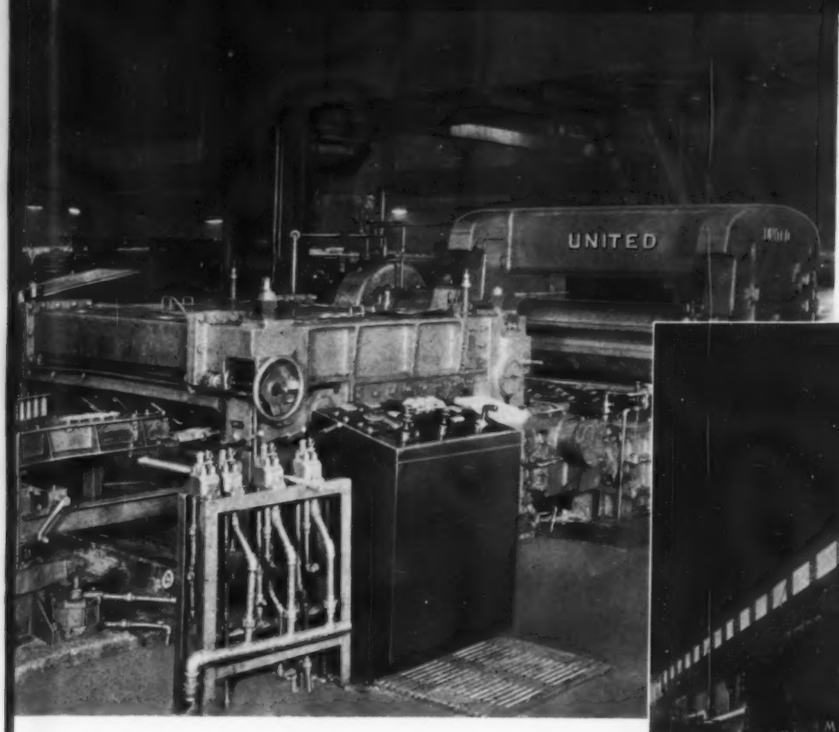
SEE THE ANALY-GRAPH IN OPERATION
BOOTH 105, IRON AND STEEL SHOW

BROWN DIVISION INDUSTRIAL INSTRUMENTS

BROWN FURNACE ATMOSPHERE RECORDER

To Measure and Control is to Economize

ANTI-FRICTION BEARING SERVICE



Vital links in the production line such as this United Slitter at the Otis Steel Company are guarded from friction problems by Rollway Bearings.

Some of the largest steel mill installations as illustrated in the opposite view of the Youngstown Sheet and Tube Company employ Rollway Bearings in many places for insuring continuous production.

BE SURE TO VISIT THE ROLLWAY EXHIBIT, BOOTH 204 AT THE IRON & STEEL EXPOSITION

Over a period of many years *solid* Cylindrical Rollway Bearings, both *radial* and *thrust* have solved the frictional and load problems on steel mill equipment. Attesting to that are the many uses of Rollway Bearings in the steel industry, on all types of machinery. Difficult problems of design and application are welcomed by Rollway engineers.

And today, Rollway is rendering a still greater Anti-Friction bearing service to you, the users.

Delivery Service—prompt, dependable, timed to your requirements—able to meet *emergency demands* because of manufacturing facilities deliberately expanded beyond routine requirements.

Engineering Service—a searching, comprehensive analysis of *your* problems.

Tieing these together with personal attention and field *service*, a representative in all steel centers to study your requirements on the spot.

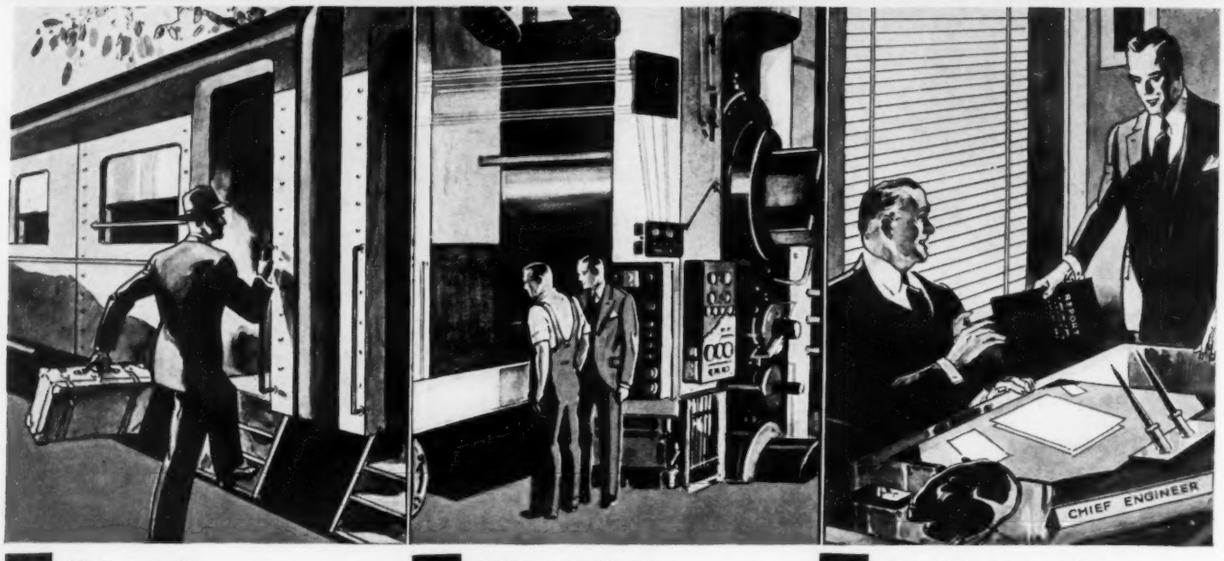
Your interests suggest getting in touch with Rollway where *bearing service* is a factor.

CYLINDRICAL ROLLER

ROLLWAY BEARINGS

Let a DIXON *Engineer*

DO THESE THREE THINGS TO SAVE YOU EXPENSE



1 Visit your mill

2 Study your roll-neck lubrication and conduct tests

3 Report his recommendations

As a result of this Dixon service, many rolling mills are today saving in lubricants, lubrication costs and maintenance of brasses—in some cases as much as $1,000 a year without any capital investment. The service is gratis, does not interfere with operations and develops dependable data based on the use of special test equipment developed for this purpose. Write Dept. RN-18 for complete particulars.

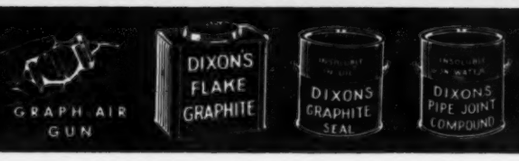
See Our Exhibit—Iron & Steel Exposition—Booth No. 222

JOSEPH DIXON CRUCIBLE CO.
JERSEY CITY NEW JERSEY

GRAPHITE EXCELLENCE SINCE 1827

DIXON'S GRAPHITE PRODUCTIONS

"and what a help these are"



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Installed in 1896 . . .

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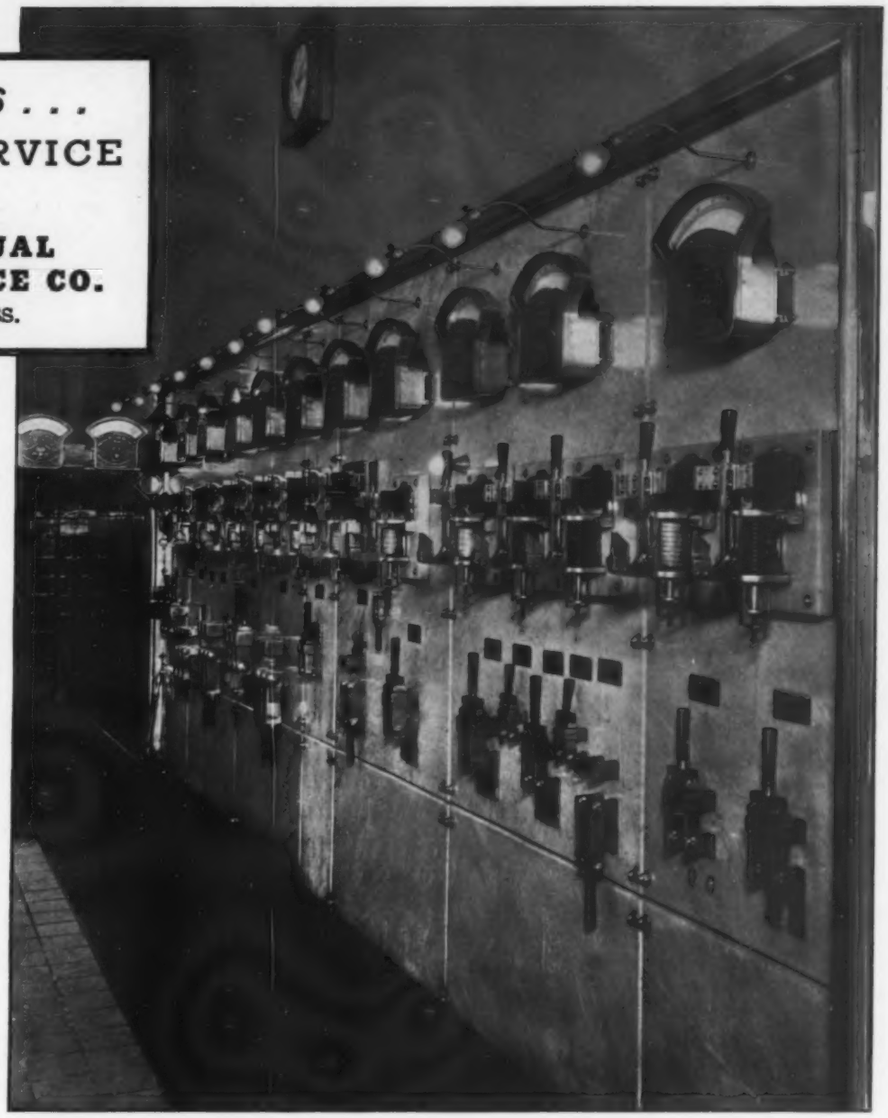

"Never failed to function on overloads or short circuits . . .

Never needed any repair parts except to renew the carbons,"

says the Chief Engineer who has been on the job through the entire 41-year period.

Pioneer AIR CIRCUIT BREAKERS by I-T-E

The service record, briefly given on this page, is typical of the experience of engineers who, by adopting I-T-E circuit breakers in the early days, became pioneers with us.

The circuit breakers illustrated were arranged to open instantaneously on current above a pre-set, adjustable value. At that time, no method existed for keeping a circuit breaker closed during momentary starting peaks. It was necessary to adjust the setting high enough to permit switching operations.

In the years since the installation of this board, I-T-E has continued to develop and introduce new methods in protection. Ability of circuit breakers to discriminate between tolerable and unsafe conditions has been raised to the point that a modern I-T-E circuit breaker can be truthfully said to "use its head."

The latest word on I-T-E discriminating features is in Bulletin 237, "Keeping A-C Motors in Operation" . . . a copy of which will be sent on request.

I-T-E

Representatives in Principal Cities

I·T·E CIRCUIT BREAKER CO., PHILADELPHIA, PA.

GLARELESS GLASS

NO REFLECTION
NO GLARE

FOR A WIDER RANGE OF VISIBILITY

ANTIGLARE-glass instruments were designed by G-E engineers to give the maximum reading accuracy under all light conditions. The operator can always read the scale because there are no glaring spots, or reflections of nearby objects. This special glass gives clear, accurate readings at all times either by daylight or electric light.

This antiglare glass is standard on all G-E rectangular switchboard instruments. Additional advantages are the antiparallax scale, rounded pointer (in shape like half a lead pencil), and bold scale markings. These features make the instrument face stand out so strongly that you can easily read it from a distance of 30 feet. The rounded pointer permits readings to be taken from extreme angles. Approximate readings are possible from 100-foot distances.

You can depend on the accuracy of these instruments. They have the high torque, lightweight moving parts, and large clearances that give an excellent sustained accuracy within one per cent of full-scale value.

There is a complete line of AD-6 high-quality rectangular switchboard instruments. Write today for a copy of GEA-1758A on these instruments. Address your request to the nearest G-E sales office, or General Electric, Dept. 6—201, Schenectady, N. Y.

GENERAL ELECTRIC

430-87